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CONTENTS

DO NOT REPEAT WRONG DECISIONS IN PLANS FOR NEW MILLS

S. M. Nosenko

Deputy Director of the Alchev Steel Plant Blooming Mill

When planning new rolling mills it is essential to pay close attention to the experience of operation in the most recent mills so that the mistakes made in the equipment, the planning of the shop, the mechanization of the auxiliary production, which are revealed during operation, are not repeated. This position has not yet been fully appreciated. New mills often have to be redesigned in the third to fifth years of operation.

The four years of operation of the 1150 mm blooming and slabbing mill of the Alchev Plant have revealed many faults, they have been admitted by the designers and will be removed this year during general overhauls; these faults were not eliminated in the recently inaugurated Cherepovets and Krivoi Rog blooming mills. We will deal with some of the more important faults of the blooming mill below.

The run-in table of the blooming mill extends so far into the bay of the heating pits that it can be serviced by only one claw crane. When this crane is at the end of its travel, the run-in table and the stationary ingot chair are under it and not one of the remaining three cranes can bring the ingots for rolling without an ingot buggy.

With unexpected stopping of the ingot buggy during these periods, the rolling stops in general. For this reason (based on incomplete data) the blooming mill lost 130 hr in 3 years, thus leading to considerable losses. The table should be extended so that during repair of the first crane, the second can feed ingots freely into the stationary ingot chair. In our opinion, further extension would not be justified.

The stationary ingot chair should be transferred from the line of the mill to the rotating table, as is done in the 1150 mm blooming mill of the Dzerzhinskii Plant, and the run-in tables and the claw crane should be designed so that ingots can be fed directly onto the table.

Figure 1 shows the arrangement of the run-in section of a 1150 mm blooming mill existing (a) and proposed, more efficient (b).

The reception of the cut-off sections into the water pit and their collection are by means of electromagnets. This method is not very efficient since a crane of capacity 30 tons with a magnet, able to lift 20 tons, in the best case lifts 2-4 cut sections of total weight up to $1\frac{1}{2}$ tons and with this "load" it travels an average of 20 m to load the rotating stand from four 80-ton platforms. Therefore, 60-70% of all the cut sections must be loaded into the cars by cranes which were intended for billet transport. This disrupts the normal operation of the adjusting equipment and damages the cranes.

The collection of the cut section can be speeded up by using a box. This is conditional upon the dimensions of the pit, the height of the crane rails, the capacity and disposition of the main and auxiliary hooks of the crane.

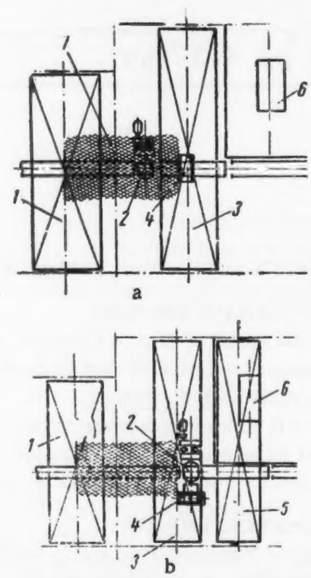
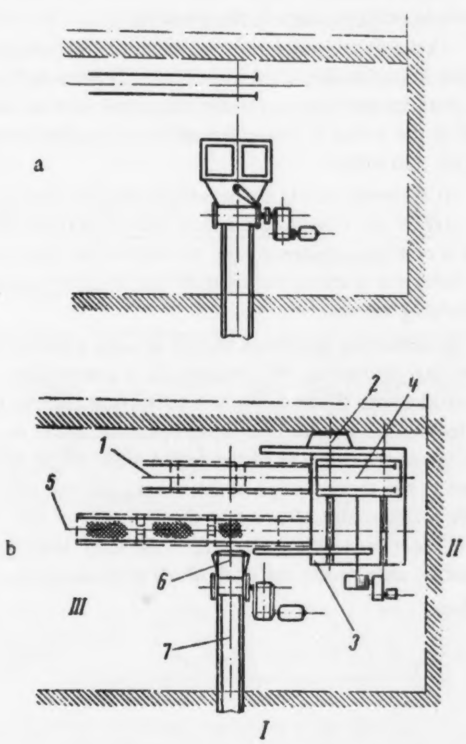


Fig. 1. The run-in section of a 1150 mm blooming mill: a) existing; b) proposed; 1) crane $\dot{Q}$ = 100/200 tons at the end of the run; 2) rotating table; 3) claw crane No. 1 Q = 20/30 tons at the end of the run; 4) stationary ingot chair; 5) crane No. 2 at the extreme position with respect to the mill; 6) the first compartment of the first group of reheating pits; 7) "dead" zone.

The best solution to the problem is to assemble the cut sections directly into special large capacity railway boxes, which will be installed in our plant. Since the railway track into the scrap bay of the blooming mill is a dead end, it was decided to use the Uralmashzavod suggestion and transfer the cars to a special moving platform (Fig.2). The empty cars move along the railway to the moving platform, which is moved by a winch from one extreme position to the other, where the boxes are filled with cut sections. A pusher then moves the empty platform into the place of the loaded platform and the freed platform goes behind the next car. This pusher moves the box under the chute of the section transporter while it is being loaded along the length of the box.

The collection of scale by the transporters at the section from the run-in table to the rear rolling table, due to rapid wear of the components, systematic wedging of the transporter with scrap and breakages in the chain leads to frequent stoppages of the mills. In the last year alone, the mill lost about 100 hr because of this.

A large amount of scale falls under the conveyor through gaps in the guide plates. A considerable amount of manual labor is expended in collecting it. A large amount of slag also collects on the roller table before the shears.



..g. 2. Collection of cut-off sections: a) existing; b) planned; 1) track for empty wagons; 2) and 3) pushers; 4) moving platform with tracks; 5) track for loaded wagons; 6) chute for section conveyor; 7) section conveyor. I) mill bay; II) billet store bay; III) scrap bay.

The use of self-powered cranes for this work has considerably facilitated the collection of the slag, but they cannot be used extensively due to the absence of tracks. From the lower tunnel, at a level of -8 m, the scale could only be collected manually. Operating experience has confirmed the possibility of reliable collection of scale with these inclines without conveyors. For this purpose the bottom of the tunnel is lined with sheet and at intervals equal to the time taken to fill the tank, 3-5 m^3 water is discharged automatically from a special tank, removing not only the scale but also the medium scrap weighing up to 1 kg. The large scrap is retained on a grating placed under the table, from where it is collected by crane once a day. The tank operates on the siphon principle (Fig. 3). The required periodicity of water ejection is established by controlling the valve which supplies water to the tank. In new blooming and slabbing mills it is desirable to plan for hydraulic removal of scale

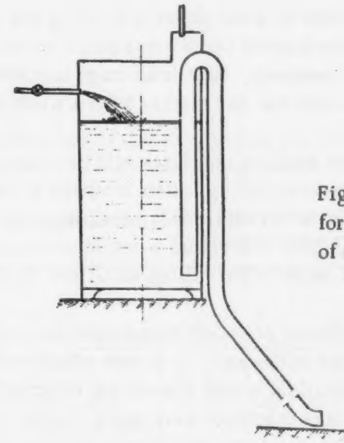


Fig. 3. Siphon tank for periodic washing of scale.

from underneath the mechanisms with simultaneous retention of the scrap on the gratings and transporting it on the conveyor for the cut-off sections.

The plan does not provide for collection devices in the third bay of the billet store, although it contains reception devices and sheet mill roller tables. This leads to incomplete use of the store areas, additional handling of the metal and additional journeys for the cranes.

In our opinion it is highly desirable to machine and load the metal at the rolling mills in the bay where it was taken from the collection devices of the blooming mill. This type of organization of the store operation will increase its rate of working, accelerate the machining, the loading and unloading of the metal.

Since at the 1150 mm blooming and slabbing mill it was also proposed to roll blooms, for their collection coolers were planned, at which the blooms should arrive and be removed in one row by the rakes of the claw cranes. The capacity of the cranes (15 tons) is used to the extent of 20-25%, and the hourly output of the mill does not exceed 30% of the planned figure (due to holdups in collection of the heats received in one bay). It is extremely undesirable to send one heat to two or three bays due to the complexity of processing, delivery and removal of the heat.

The possibility has been shown in practice of collecting blooms on platform tables with 4-5 tiers which provides full loading of the cranes and normal collection of the billet for any output of the mill (within the planned limits). In the new plans for similar blooming mills the platform tables should therefore be fitted with a rack drive for hoisting the table in all the bays of the store.

In our plant, the coolers of the second bay will be changed to a platform table and new tables will be installed in the third bay of the store.

A single-position marking machine designed to cut and mark blooms could not cope with even 40% of the mill output.

By changing over to a two-position marking machine at the Uralmashzavod two blooms could be cut and marked simultaneously. At a later stage two slabs will be simultaneously cut and marked with a width of up to 650 mm.

Three-position marking machines will be introduced with automatic switching, rulers mounted in the machine, and roller tables with speeds increasing from section to section. This will ensure a considerable increase in the mill output when rolling small and medium billets.

The mechanization of maintenance work has been somewhat neglected in the past. In a zone which is not serviced by electrical bridge cranes, the rotating table and the marking machines work under stresses and often have to be repaired. The repairs involve considerable wastage of labor and time.

The plans should therefore include the following measures:

a)the power of modern blooming mills should be increased to such an extent that the reductions, especially in the first passes, should be an optimum value, providing rectangular section of the rolled material and good surface quality;

b) the lines should include machines for selective or continuous fire refining of defects on the surface of the rolled material;

c) an instrument should be developed to automatically determine the length of the shrinkage pipe in the rolled material so that it can be accurately and completely removed;

d) each ingot which is to be rolled should be automatically weighed, recorded and the information transmitted to the rolling stand control panel and the shears in order to correct the product;

e) the actual thickness, width and length of the rolled material should be automatically recorded and the data transmitted to the control panel for the shears so that the rolled material could be more efficiently cut up into billets;

f) a system should be developed for granulating the slag in the reheating pits and pulp should be thrown into a common cinder settler, to relieve the plant of the laborious work of transporting and treating monolithic slag masses;

g) industrial television should be used extensively in rolling production; this equipment is particularly essential at the shears and when collecting the cut-off sections in the wagons; the shear operator should be able to see the position of the rolled material in relation to the cutting edge of the shears, the cut end of the rolled material and also the behavior of the cut-off section on the transporter; the shop despatcher should be able to see the work of all sections of the shop.

INCREASING THE SPEED OF CHARGE CONVEYERS IN A SINTERING PLANT

D. P. Pritykin

"Zaporozhstal'" Plant

In 1951 the sintering plant began operation with only 4 K-2-50 sintering machines. The charge from the charge section was fed into the sintering unit by two parallel independent lines, consisting of 5 conveyers each (see diagram). The specifications of these conveyers are given in Table 1.

TABLE 1

The Planned Specifications of the Charge Conveyers

Index	No. of conveyers				
	24 & 25	26 & 27	28 & 29	30 & 31	32 & 33
Output ton/hr	400	400	400	400	400
Length of conveyer, m	129	15.5	64	105	41
Height of hoist, m . .	3.3	4.4	23.3	34.2	2.5
Angle of inclin. deg	18	18	22	18	18
Width of belt, mm	800	800	1000	1000	800
No. of linings in the belt	7	6	8	8	6
Speed of belt m/sec	1.02	1.54	1.72	1.77	1.32
Power of motor, kw	25	11	61	85	15
Speed of motor, rpm	980	980	980	1480	980
Gear ratio of reduction gear	40.16	20.7	29.05	43.76	24.4

Another two sintering machines were put into operation in 1954. The charge conveyers and the recovery unit were redesigned, the width of the belt and its speed being increased. This increased the output to 750 tons/hr (conveyers No. 32 and 33 were also extended for loading the charge of two additional sintering belts (Table 2). The production of sinter in the shop increased constantly and in 1956 the charge line began to hinder the loading of the sintering machine with charge. The conveyers had to be loaded above the planned capacity, the old motors being replaced with new, more powerful motors; this, however, did not ensure normal operation of the conveyers and loading of the sinter belts with charge.

In order to further increase the output of the conveyers, in June and July 1957 the workers of the "machine components" department of the Zaporozh Engineering Institute together with factory workers studied the operation of conveyers* and came to the conclusion that the equipment could be redesigned in three ways: by increasing the width of the belt, the speed of the belt and also the speed and the width of

TABLE 2

Characteristics of Conveyers after the First Redesigning

Index	No. of conveyers				
	24 & 25	26 & 27	28 & 29	30 & 31	32 & 33
Output ton/hr . . .	750	750	750	750	750
Length of conveyer, m	129	15.5	64	105	61
Height of hoist, m . .	3.3	4.5	23.3	34.2	1.1
Angle of inclin. deg.	16.5	20	20	18	18
Width of belt, mm	900	1000	1000	1200	1000
No. of linings in the belt	8	10	10	12	10
Speed of belt m/sec	2	1.55	2.1	2.08	1.75
Power of motor, kw	34	20.5	85	115	20.5
Speed of motor, rpm	975	980	1480	1480	980
Gear ratio of reduction gear	20.5	26.9	36.86	36.86	23.34

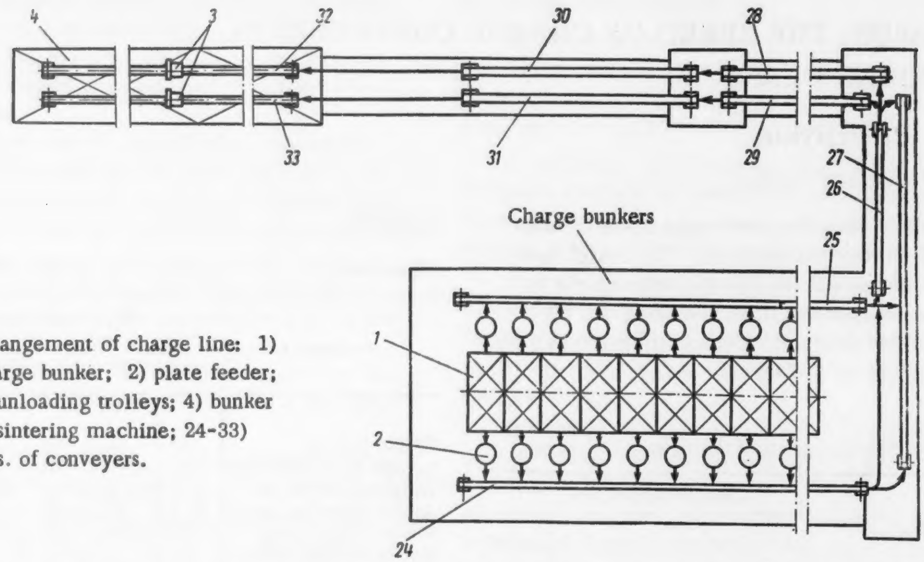
the belt. Increase in the belt width would require complex redesigning of all galleys and working areas. It was therefore decided to redesign the conveyers by increasing their speed.

Table 3 gives the specifications for the conveyers according to this design.† In the redesigning, the electrical motors and reduction gears were changed. At the same time the drums were mounted on antifriction bearings, the shafts were strengthened as well as the bearings of the supporting rollers, centralized lubrication of all bearings was provided, the frames of all driving stations were strengthened and fastened. The ramps of the pulling station trolleys and the cable blocks were also converted to antifriction bearings, the hoppers were straightened out and lined with armor plate made of hardened sheet steel 70 Kh and modernized reduction gears were introduced.

As well as the usual electrical safety precautions and the interlocking of the conveyers, the electrical equipment had elements which permitted their operation to be automated: tachogenerators, checking the slipping of the belt and its tearing; final switches for moving the belt to the side; final switches to prevent overloading of the loading hopper, which at first give an impulse for switching on the vibrator and only after

* The investigations were supervised by D. S. Volkov.

† The plan was drawn up by the design section of the plant.



Arrangement of charge line: 1) charge bunker; 2) plate feeder; 3) unloading trolleys; 4) bunker of sintering machine; 24-33) Nos. of conveyers.

a certain length of time, if the hopper is not freed, do they switch off the motor.

To check the release of the electrohydraulic brakes, the drives had final switches which allowed the motor to be started. The limiting position of the holding station was also controlled by a final switch.

Operation of the conveyers with increased speed showed that with vulcanization of the joints, the drums lined with rubber belts, correct installation of the drums and supporting rollers, the conveyer operates completely reliably. When these conditions were not observed, the conveyer No. 32 operated unreliably (the belt wedged between the drums and the hopper and also on the chassis of the unloading trolley) and it was therefore necessary to change to a reduced speed (2 m/sec) from time to time.

Since the Soviet industry does not produce electromagnetic brakes which can be switched on 100% of the time, the inclined conveyers were equipped with block

TABLE 3. Specifications of the Charge Conveyers after the Second Redesigning

Index	No. of conveyers				
	24 &25	26& 27	28& 29	30& 31	32 & 33
Output in tons/hr. .	1200	1200	1200	1200	1200
Speed of belt, m/sec.	2.63	2.61	2.89	3.3[illegible]	2.59
Power of motor, kw	75	40	130	210	34
Speed of motor, rpm	985	980	980	735	975
Gear ratio of reduction gear	15 75	15.75	17.775	11.41	15.75

brakes with electrohydraulic push rods TKTG-400. The retarding torque of this brake was as high as 15000 kg cm.

To provide good reliability, on the drives of the heavy inclined conveyers (Nos. 28, 29, 30, and 31) two brakes were installed on both ends of the driving shaft of the reduction gear.

The operation of these brakes at the sintering plant showed that they give reliable braking when the conveyers are stopped with a load of charge if the conveyer has to be stopped once or twice per shift for safety reasons. On operation without stopping for several shifts under conditions of dusty and corrosive atmospheres, the brake may fail to work or be slow due to seizures in the hinges of the lever system.

The economic efficiency of the new design is obvious. High capital expenses are not required in changing over the conveyers. To increase the output by 450 tons/hr the costs were half of the initial costs when the line had an output of 400 tons/hr.

Investigations and calculations showed that on increasing the speed of the conveyors to 4 m/sec with practically the same costs, an output of 1500 tons/hr could be achieved. It is true that with increase in the speed there can be increased wear of the belt due to the increased amount of flexing, but due to the reduction in the circumferential force and the load on the belt (with the same output and increase in speed) this should not cause much danger. With increased speed there is an increase in the dynamic loads on stopping and starting: this, however, can be reduced by using an appropriate electrical apparatus to control the motors.

The final decision on the service of the belts can only be made after extensive operating experience.

* * *

THE AUTOMATIC COLLECTION OF DUST FROM THE BAGS OF THE GAS PIPE AND THE MULTICYCLONE

A. K. Rudkov

Head of the Dzerzhinskii Sintering Plant

Material which is being sintered partially falls through the grate of the moving trolleys, falls into the vacuum chamber and from here enters the gas pipe. The larger particles are deposited in the bags of the gas pipe and the fine particles are trapped in the multicyclone and also collect in their bags. The dust from the bags and the pipe of the multicyclone are removed manually or mechanically through double valve seals, which requires the expenditure of manual labor.

As well as these methods, methods have also been developed for the pneumatic and hydraulic collection of the dust, but they require high capital expenses.

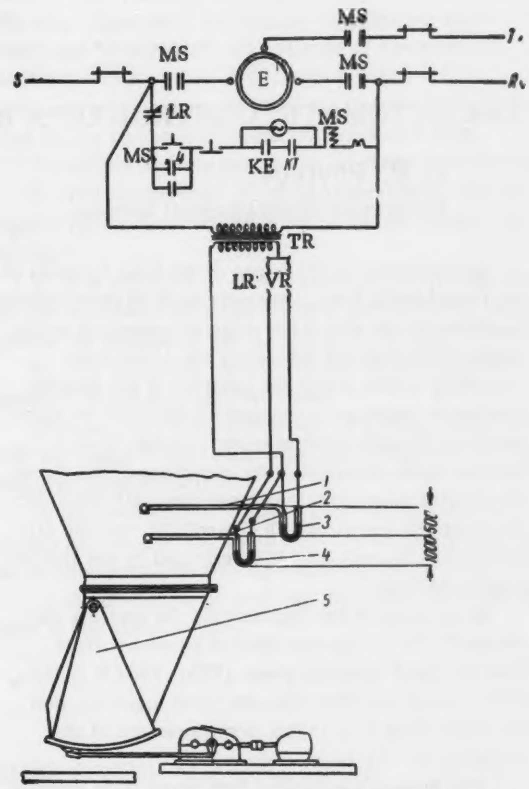
The vacuum automatic seal (diagram) for collecting dust from the bags of the gas pipe and the multicyclone differs from the existing arrangements in that the sealing device for the dust bag is the trapped dust itself, which is periodically distributed by a pendulum feeder driven by the electric motor.

The operating principle of the vacuum seal is as follows.

The bag contains two metal pipes of 15 mm diameter with the ends bent downward and placed at the axis of the bag. Holes of 2-3 mm diameter are drilled in them and two U-tube mercury manometers are connected by means of rubber tubes, the mercury containing the contacts. When there is no reduced pressure in the bag the contact of the lower manometer should be 30-50 mm above the level of mercury and the contact of the upper manometer should touch the mercury.

After the vacuum automatic seal has been installed, it is essential to collect sufficient dust in the bag so that the end of the lower metal tube is completely covered by it and the level of the mercury in both arms of the lower manometer is the same. For this purpose the holes for distributing dust from the pendulum feeder are carefully stopped up with clay. When the dust closes the end of the pipe, the holes are opened. During this time air is not sucked in.

During operation of the sintering machine, the dust will collect and cover the end of the upper metal pipe. The vacuum in the tube falls to zero with time. In this position the mercury of the manometer closes the contact, switches on the intermediate relay UR, which in its turn switches on the magnetic starter of the electric motor of the pendulum feeder. The feeder will distribute dust from the bag until the end of the bottom metal pipe is uncovered. As soon as



Automatic vacuum seal: 1) upper pipe; 2) lower pipe; 3) upper manometer; 4) lower manometer; 5) pendulum feeder; R, S, T) the phases of the alternating current; LR) coil and contacts of lower pipe relay; UR) coil and contacts of upper pipe relay; TR) transformer; E) electrical motor; KE and KT) the interlocking contacts of the feeder with the exhauster and transporter for collecting the dust; MS) coil contacts of the magnetic starter.

this happens, the mercury of the manometer is raised under the action of the vacuum and closes the lower contact, the intermediate relay LR is switched on, which breaks the feed circuit of the magnetic starter. The electric motor is switched off and the distribution of dust stops. The dust again collects, the upper metal tube is covered and the electric motor is switched on again. To prevent complete distribution of dust from the bag, the vacuum auto-

matic seal is interlocked with the exhauster and with the conveyer for collecting the dust.

Experimental vacuum automatic seals which have been installed on the recommendation of the author at one of the Dzerzhinskii Plant sintering machines operate entirely satisfactorily. They prevent the harmful sucking through of material when collecting dust from the gas pipe and the multicyclone, they increase the output of the sintering machine and reduce the consumption of electrical power by the exhauster. They free four men per day for work in other sections, eliminate the expenses on repairs and double valve seals and improve the working conditions for the workers in the sintering unit.

New designs for sintering plants should include these seals. They considerably simplify the design of sintering units.

* * *

THE AUTOMATIC CONTROL OF A ROTATING DISTRIBUTOR

V. P. Pevtsov

Dnepropetrovsk Metallurgical Institute

In December 1957, at one of the blast furnaces of the Dzerzhinskii Plant, tests were made on an automatic regulator for the rotating distributor, operating on the design of the Central Laboratory for Automatics. According to this design the program of the rotating distributor operation is changed by means of an automatic instrument which receives impulses from 6 thermocouples arranged in the periphery of the throat. The programming device is connected with the existing electrical circuit which controls the rotating distributor and its operation is determined by the thermocouple readings.

In the tests of the regulator for the rotating distributor* the charge consisted of Bessemer sinter from the local sintering plant (71%), YuGOK sinter (16%), which was finer than the local material, iron ore of the third class (13%), manganese ore of the second grade and metal additions.

The furnace was loaded from seven skips according to the arrangement CCOCOL$\downarrow$C$\downarrow$ at a level of 1.5 m. The bell had to be lowered twice due to the insufficient volume of the hopper of the large bell which could only take material from six skips.

The distribution of materials in the skips was as follows:

No. of skip	Material	Quantity, tons
1	Coke	1.7
2	Coke	1.7
3	Sinter	5.0
	Ore	2.3
4	Coke	1.7
5	Sinter	6.0
	Dolomitized limestone	1.7
6	YuGOK sinter	2.5
	Normal limestone	2.0
7	Coke	1.7

Bessemer iron was smelted with 0.8-1.3% Si, with high slag basicity and throat pressure of 0.6 atm. The iron was tapped 7 times per day. The operating parameters of the furnace were reduced to the fact that the furnace was often incompletely filled due to shutdowns in the loading system.

Round-the-clock working of the automatic instrument and observations on the furnace were commenced on the 8th of December, 1957. At first it was feared that the change in operation of the rotating distributor and the blocking-up with ore of the place where the channel forms in the charge would lead to simultaneous disintegration of the charge at another place and to displacement of the channel. However, the first observations showed that after 1½-2 hr of operation of the automatic regulator, the difference between the temperatures of the peripheral part of the furnace were reduced from 200 to 250° to 50-70°, and were kept at that level throughout the whole time of operation of the automatic system. Nevertheless, despite the prolonged preparation of the instrument for round-the-clock operation, in the period from the 8th to 16th of December the electrical part of the regulator worked intermittently, leading to incorrect readings of the instrument or to its failure.

This made the observations very difficult since, apart from the frequent incomplete filling of the furnace, there were interruptions in the operation of the rotating distributor regulator.

Observations of the furnace operation with the automatic regulator during normal periods with the established pouring level show that the temperature of

* The work was supervised by Professor A. D. Gotlib. The test were carried out by workers from the TsLA (Central Laboratory for Automatics) of the Dzerzhinskii Plant, Dnepropetrovsk Metallurgical Institute and the Dneprodzerhinskii Metallurgical Evening Institute.

the peripheral gases remains uniform and this in its turn leads to uniform distribution of the gas stream. Even with incomplete filling of the furnace (up to 2-2.5 tons and below) and with the automatic instrument operating, the temperature of the peripheral gases became more uniform. In further more extensive tests of the operation of the automatic instrument it will be essential to establish the technical and economic factors of the blast furnace smelting when operating with a rotating distributor with a regulator and to compare them with operation of the distributor with the usual system.

During the observations certain faults were found in the automatic instrument. The arrangement only allows for two systems of operation whereas it is frequently necessary to have a large number of systems. The apparatus of the regulator was insufficiently reliable which meant that the automatic system was often idle.

The automatic regulator tested had two systems of operation.

1. The maximum-minimum system, in which two feeds are added to the point with the maximum gas temperature and only one feed to the point with the minimum temperature.

2. The maximum system, in which there are two feeds to the zone with maximum temperature and one each to the other stations of the distributor.

When operating with these systems, cases were observed where the automatic system considerably reduced the maximum temperatures of the gas stream but did not raise the temperature at the points where it was a minimum, despite the extensive operation of the instrument (8-12 hr).

In the "maximum-minimum" system it should be possible to double the permissible number of stations in the zones with minimum temperature; in this way it will be possible to increase the temperature of the peripheral gases in the zone of minimum temperatures.

It is also essential that the distributor should be able to operate with any number of stations (3,2 or even 1). The existing automatic system does not provide this. Apart from the systems "maximum-minimum" and "maximum" (with change in operation to minimum temperatures) the program device of the automatic regulator should allow for the possibility of operation at any station with twice the number of skips.

The following conclusions can be drawn from the tests.

1. The temperature of the peripheral gases is a reliable impulse for the automatic control of the gas stream "from the top."

2. It is desirable to use an automatic system to control the distributor operation since it provides even temperatures in the peripheral gas streams in the throat.

3. The following systems should be provided for the operation of the rotating distributor:

a) twice the permitted number of stations at the point with the lowest temperature when operating with the "maximum-minimum" system;

b) the possibility of operating the arrangement with any number of stations (3, 2 and even 1) during a certain number of feeds with one-way operation of the furnace;

c) the possibility of doubling the operation of the distributor at the given stations.

* * *

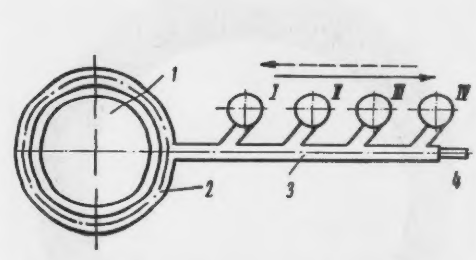
AN EFFICIENT SEQUENCE FOR SWITCHING OVER AIR HEATERS

I. A. Ivanov, Gas worker at Blast-Furnace Shop
Magnitogorsk Metallurgical Combine

To maintain the normal temperature of the blast it is essential to observe correct sequence in switching over the air heaters to "blast." Operating experience shows that the most efficient sequence for switching over is I -- II -- III -- IV (See figure).

In fact, with the reverse order of switch-over, i.e. IV – III – II – I, after the I air heater, IV should be put on "blast." By this time the whole section of the straight air pipe from IV to I of the air heater will be cooled by the cold air and in heating it a part of the heat will be wasted from the air heated in the IV air heater.

If the air heaters are switched over to "blast" in the order I – II – III – IV, then the section of the straight air pipe will be heated not in one but in three ways: at first the section between the I and II air heaters is heated,



Sequence for switching over air heaters to "blast" (the full arrow shows the direction of efficient switch-over, the broken arrow shows the direction of inefficient switch-over): 1) blast furnace; 2) annular air pipe; 3) straight air pipe; 4) mixing air pipe (the Roman numbers indicate the numbers of the air heaters).

then between II and III, etc. The heating and cooling of the straight air pipe will therefore proceed uniformly, thus making it easier to maintain the given blast temperature and to use the air heaters more efficiently.

* * *

A NEW DESIGN FOR A HOT BLAST VALVE

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Dzerzhinskii Plant

Our plant uses hot blast valves with cast bronze rings and bronze gate valves.

The faults of these valves are:

1) the scarcity and expense of the bronze;

2) the friable surface of the bronze castings, reducing the thermal conductivity of the component. The thermal conductivity is still further reduced by the deposition of sludge and scale;

3) the presence of holes for removing the mold material in which plugs are placed weakens the sections of the ring and leads to the formation of cracks;

4) sometimes as the mold is being filled the core erodes, giving rise to local thickening of the wall of the ring or gate valve. Because of this, some sections of the castings are overheated and large thermal stresses are induced in them, leading to the formation of transverse cracks in the thick sections.

Figure 1 shows the characteristic failure of rings mainly due to thermal stresses. The burning of the rings and the formation of cracks mainly occurs in the top part of the ring. In the welded rings of sheet copper the failure mainly occurs in the outside diameter (Fig.2). Three years ago at the Dzerzhinskii Plant a new design for the gate valve and ring was developed.

The gate valve of welded design consists of a basic ring cast from furodite * with the internal surface machined. On the inside surface there are two annular ribs to give rigidity and increase the cooling surface. Side walls of ordinary or high chromium steel are welded to the ring; ribs are welded to one of these walls. Before the side walls are welded, a pipe is fitted to feed water into the lower part of the gate valve. This supply of water makes it possible to improve the heat exchange in the hotter part of the gate valve. The side walls are fastened by supports on electrical rivets. Two brass belts are welded on to reduce friction when the gate valve moves.

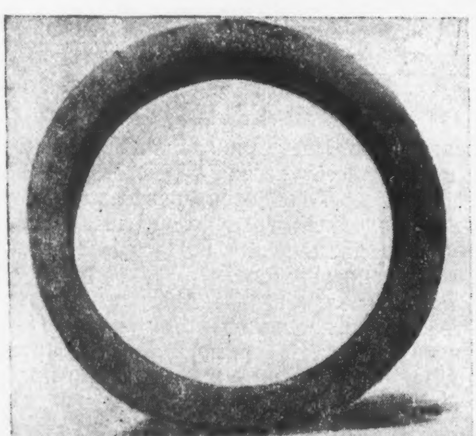

Fig. 1. Characteristic failure of a bronze ring.

The ring of welded design consists of a main ring also made from furodite. The machined internal surface of this ring has three annular ribs for rigidity and to increase the cooling surface. A stop is welded to the main ring; the welding seam is concealed on assembly into the body of the valve.

The operation of these rings revealed certain design faults. Due to the small diameter of the openings for the water, steam pockets formed inside the component. The high pressure of the superheated steam broke the ring. The relatively low thermal conductivity of the furodite, due to the high chromium content, induces considerable local stresses, also breaking the ring.

The results of the experiments indicate that the rings should be made without cooling. The material of the ring should have a low coefficient of linear expansion and should resist changes in temperature. Fireclay has these properties.

Separate segments were made by wet pressing of a refractory mass with a high proportion of fireclay; the rings were assembled from these segments (Fig. 3). The segments were roasted and after appropriate alteration a ring was assembled with the same fireclay solution. The

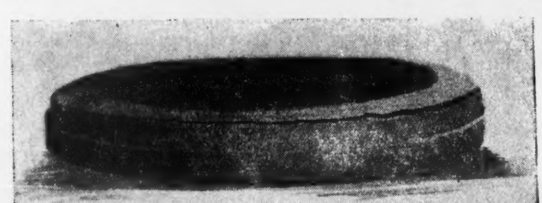

Fig. 2. Characteristic failure of a welded ring of sheet copper.

* An alloy of iron containing 27-29% Cr and about 5% Al.

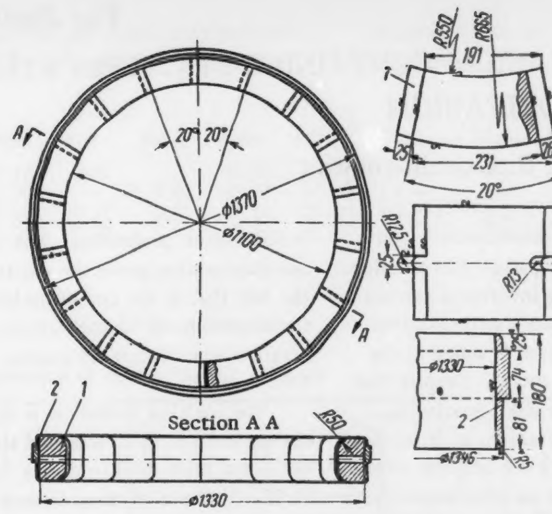

Fig. 3. Fireclay ring: 1) segment; 2) band.

ring was ground on the periphery and the lateral surfaces on a vertical machine. After the surface layer had been removed no pores were detected at the segment joints.

The segments were contained in a band made of commercial steel St. 3. The band was fitted in the hot state on to the preheated ceramic ring. The coefficient of linear expansion of the material of the band is much higher than that of the refractory mass. The weak contact between the ring and the band is not dangerous during operation since large displacements of the ring in the body of the valve are prevented by the lateral walls of the body. This weakening is even useful since it increases the air gap between the ring and the band, which reduces heat transfer from the ring to the band.

The fireclay rings were installed in the housing of a valve at one of the blast furnaces.

THE SMELTING OF TITANIUM-CONTAINING STAINLESS STEEL WITHOUT USING FERROTITANIUM

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"Elektrostal'" Plant

At the present time an alloy of ferrotitanium containing 25-28% Ti is used for alloying steel with titanium. The use of ferrotitanium for alloying involves a number of technical difficulties. The titanium easily oxidizes and to reduce wastage the ferrotitanium is added at the very end of the smelting to the bare metal. Despite this precaution, the titanium waste is 45-50%. Bearing in mind that in the production of ferrotitanium at ferroalloy plants the extraction of titanium from the original mineral material is about 70%, then the total use of titanium from the mineral material is more than 35%.

Stainless steels for which ferrotitanium is mainly used are mostly smelted with gaseous oxygen. A large quantity of slag is formed in the furnace and it must be completely removed before the ferrotitanium is added. If the slag is only partly removed, then the ferrotitanium added to the furnace reduces the silicon from the slag which means there is an increased waste of titanium and increased content of silicon in the steel. For this reason, the stipulated content of Ti and Si cannot be obtained in the steel.

After the ferrotitanium is added to the bare metal in the furnace, a slag mixture is added to prepare the melt for tapping. The addition of ferrotitanium and the introduction of the new slag sharply reduce the temperature of the metal immediately before it is tapped into the ladle. It is very difficult to compensate for this reduction in temperature by additional heating of the metal bath: after the ferrotitanium has been added the metal cannot be kept for long in the furnace because of the intensive burning of the titanium. It is therefore very difficult to obtain the required titanium content in the steel.

At the "Elektrostal'" Plant, tests were made of the alumothermal reduction of Ti from TiO_2.

In various steels, tests were made for this purpose of chemically pure titanium dioxide (99.9% TiO_2), prepared by the paint factories. Experiments confirmed the possibility of alloying steel with titanium in an electric arc furnace. However, the high cost of titanium dioxide makes it unsuitable for permanent use in steel smelting.

It was found suitable and technically convenient to directly alloy acid-resistant steel 1Kh18N9T using ilmenite concentrate – the widely used material for ferrotitanium production. The use of this material does not require changes in the existing technique except for the fact that at the end of melting instead of adding ferrotitanium, an alumothermic mixture of ilmenite concentrate with aluminum powder and certain other additions is added.

The melting technique is then as follows. The charge is made up of waste of stainless and low-alloy steels and mild steel to give a content of about 12% Cr, 12.5% Ni, about 1% Si and about 0.35% C. Gaseous oxygen is used to accelerate the process of fusion. After the charge has melted, the bath is blasted with oxygen to boil the metal and remove the excess carbon. The slag is then deoxidized with 45% ferrosilicon and the calculated quantity of ferrochrome is added to the furnace. After complete fusion of the ferrochrome, all the slag is removed and alumothermic copper is added to the bare metal.

In many melts the ferrochrome was added to the furnace immediately after the oxidizing blasting, and the deoxidation of the slag coincided with the fusion of the ferrochrome. A carefully mixed alumothermic mixture was loaded into the furnace from charging boxes using a charging crane with the current switched off. The titanium reduction took place smoothly but rapidly (1 min. for each charging box of the mixture). After all the mixture ready for the smelting has been added, a mixture was added without interruption, consisting of lime and fluorspar (2:1), 17 kg/ ton of ingots, and the current was switched on. This addition was needed to melt the slag. After 7-10 min after the finish of the addition, the metal was tapped.

In determining the composition of the alumothermic mixture the factors considered were the stoichiometric calculations and the conditions for obtaining slag with suitable mobility, flowing freely from the furnace and not sticking to the walls of the ladle.

On the basis of the experimental melts, an optimum composition was selected for the alumothermic mixture, tested on the following heats (see table).

The metal of the experimental melts for 1Kh18N9T steel, alloyed with titanium by means of the mixture of composition shown in the table, had the following chemical composition, %:

No. of Heat	C	Si	Mn	S	P	Cr	Ni	Ti	Cu
A-48393	0.09	0.56	1.12	0.012	0.028	18.28	10.47	0.34	0.32
A-48444	0.07	0.36	0.90	0.011	0.029	17.85	10.90	0.33	0.20
A-49054	0.08	0.44	0.85	0.016	0.026	17.50	10.60	0.42	0.20
A-49057	0.08	0.60	1.04	0.014	0.029	17.95	10.60	0.49	0.20

In its chemical composition, the metal obtained fulfills the GOST requirements for acid-resistant steel for pipe billets.

In these melts, the slag before tapping had the following composition, %:

No of Heat	SiO_2	MnO	FeO	Fe_2O_3	Al_2O_3	CaO	MgO	Cr_2O_3	TiO_2	Extraction of titanium from concentrate, %
A-48393	2.26	0.16	2.51	—	44.60	39.89	4.78	Tr.	4.34	39.0
A-48444	1.70	0.20	—	2.51	48.71	34.88	4.61	Tr.	5.78	38.0
A-49054	0.50	0.26	0.71	0.81	51.20	29.40	9.77	Tr.	5.88	45.7
A-49057	2.30	0.06	0.79	1.02	49.66	41.47	2.14	Tr.	2.08	54.0

Optimum Chemical Composition of Alumothermic Mixture

Materials	Quantity	Chemical composition, %					
		SiO_2	CaO + MgO	MnO	Fe_{tot}	TiO_2	Remainder
Calcined Urals ilmenite concentrate	38	1.53—3.03	—	0.44—1.87	34.35—33.80	41.6—43.05	—
Powdered "Sin'ka" iron ore	4	2.20	—	—	66.82	—	—
Lime, powdered	4	1.02	93.0	—	—	—	1.8
		Al	Si	Cu	Fe	Zn	
Powder of secondary aluminum	19	90.0—93.1	1.67—1.85	2.8—2.5	1.04—1.50	0.25—0.36	

The slag was fairly mobile and was completely removed from the furnace.

The economic advantage in using ilmenite concentrate is due to the difference in cost of ferrotitanium and the materials replacing it and the reduction in time of the melting. The savings in the replacement of ferrotitanium are about 100 rubles for 1 ton of ingots. The alloying technique using ilmenite concentrate has not yet been fully worked out and can be considerably improved. In the experimental heats, the melting time was reduced by 5-10 min.

The following conclusions can be drawn from the above work.

The alloying by titanium of acid-resistant steel 1Kh18N9T by the alumothermic reduction of titanium from ilmenite concentrate is entirely feasible; it eliminates the inconvenience of working with ferrotitanium, accelerates the melting and facilitates the production of metal with required contents of the various elements.

The extraction of titanium from ilemenite concentrate usually varies between 38 and 45% which means that the over-all extraction of titanium from the original raw material is higher than when alloying steel with ferrotitanium. The use of ilemenite concentrate instead of ferrotitanium, due to the difference in cost of materials alone, reduces the cost of 1 ton of 1Kh18N9T steel by 100 rubles.

FIRING AN OPEN-HEARTH FURNACE WITH NATURAL GAS

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Natural gas is a valuable fuel for open-hearth furnaces since it has a high calorific value and does not contain harmful impurities.

As part of the development of the national economy of the USSR from 1959 to 1965, the 21st Conference of the Communist Party has decided to increase the extraction and production of gas to 150 billion m^3 by the end of the seven years, thus providing the essential conditions for the extensive use of high calorie fuel for firing open-hearth furnaces.

The main difficulties arising when firing open-hearth furnaces with natural gas are due to the insufficient illumination of the flame when burning cold gas emerging at high speeds. To increase the illumination at the K. Libknekht and the Tagan Rog Steel Plants, fuel oil was added to the natural gas, the consumption of which is usually 30-40% based on the heat. The use of fuel oil for carburation of the flame requires the organization at the plant of a huge fuel oil system, which makes the construction of new shops more expensive and prevents open-hearth furnaces operating on mixed gas from being converted to natural gas.

There is also a method for increasing the illumination of the natural gas flame by its self-carburation, i.e., decomposition of the methane with the formation of carbon black. When methane is heated in the absence of oxygen, i.e., thermal decomposition, hydrogen and carbon black are formed with a high degree of dispersion, being evenly distributed in the gas. As well as the carbon black there is a certain amount of tar and light oil, which also increases the illumination of the flame. When methane is heated in the presence of oxygen the products of the decomposition also contain carbon black and a certain amount of the heavy hydrocarbons.

Consequently, by burning methane in the checkerworks with a coefficient of air excess less than unity, due to the thermal and oxidizing decomposition, decomposition products can be obtained which contain carbon black and the higher hydrocarbons which provide the necessary illumination of the flame.

Under the direction of Academician N. N. Dobrokhotov, a method has been developed for firing open-hearth furnaces with cold natural gas with self-carburation. In this method the natural gas before combustion in the working space of the furnace is preliminarily heated by the heat given out when a part of the gas burns in the head and also by the heat accumulated by the lining of the head.

In the iron and steel casting shop of the K. Libknekht Plant, using the Ukrgipromez design, one of the open-hearth furnaces was converted during the cold maintenance to firing with cold natural gas with self-carburation.

Gas from the Shebelinskii deposit at a pressure of 2.5-3.0 atm was fed to the furnace along a gas pipe (Fig. 1) of diameter 4 in. in which there was a measuring diaphragm (to determine the total amount of gas supplied to the furnace) and a control valve. After the control valve the gas is fed to the heads of the furnace; in the gas pipes leading to the heads there are stop taps. Before changing over to natural gas, the open-hearth furnace operated with fuel oil and had one pair of slag chambers and two vertical air ducts.

When the furnace was changed over to natural gas, a third middle vertical duct was made in the head, connecting the slag chamber with a water-cooled caisson arranged along the longitudinal axis of the working space as in the case of furnaces with gas firing. The design covers various methods for introducing the natural gas into

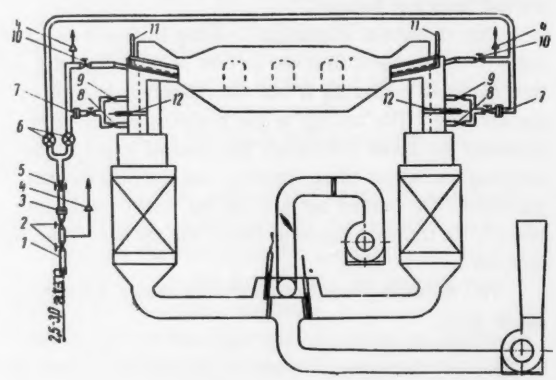

Fig. 1. Arrangement for feeding natural gas to an open-hearth furnace: 1) gas pipe of diameter 4 in; 2) slide plates; 3) diaphragm for common gas pipe; 4) outlet pipe with stop cock; 5) control cock; 6) branch cocks; 7) diaphragm for pipe of lower burners; 8) valve for burner installed under working platform; 9) valve for burner installed above the level of the working platform; 10) slide plate for burner fixed at end of caisson; 11) supply of compressed air; 12) control gate valve.

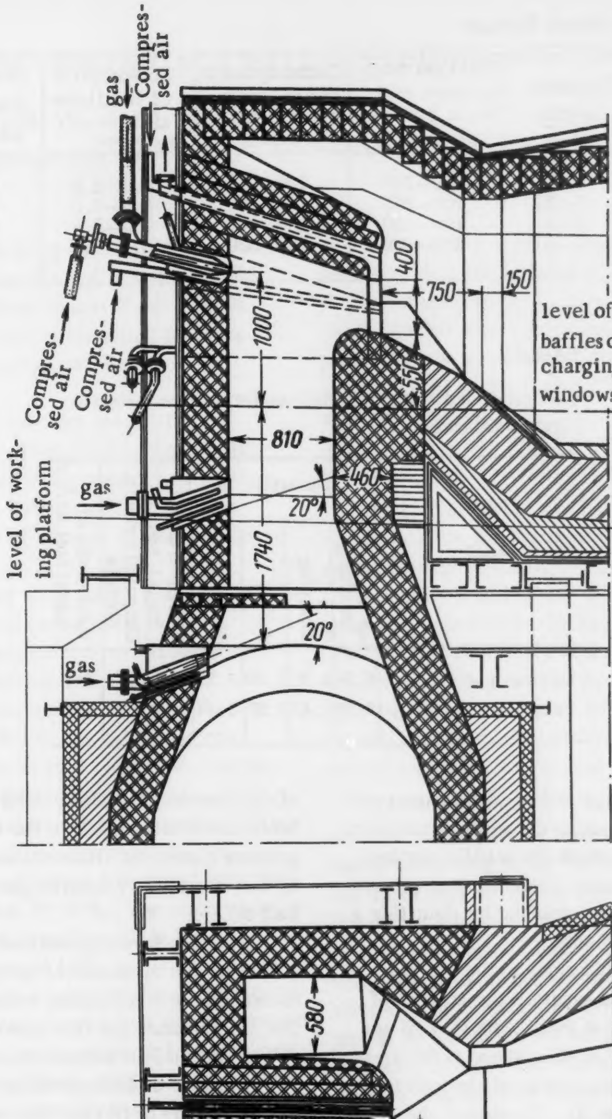

Fig. 2. Design of head for firing a furnace with natural gas with self-carburation.

TABLE 1

Thermal System of Open-Hearth Furnace

Smelting period	Duration hr-min	Total gas usage to upper and lower burners m^3/hr (NTP)	Consumption of gas to lower burners m^3/hr (NTP)	Consumption of ventilator air 1000 m^3/hr (NTP)	Pressure under the roof, mm water gage	Time between transfers, min
Dressing	0–15	500–550	150–300	5.0–5.2	1.5–2.0	5–10
Charging	1–25	600–650	150–400	6.5–7.0	2.5–3.5	10–15
Fusion	1–20	600–650	200–400	7.0–7.5	2.0–3.0	7–10
Finishing	1–30	500–600	200–350	6.0–7.0	2.0–2.5	5–7

TABLE 2

Technical and Economic Indices for an Open-Hearth Furnace Operation

Fuel	Duration, hr				Weight of useful metal, tons	Output of furnace, tons/hr	Spec. cons. of ideal fuel, kg/ton
	of whole smelting	charging	fusion	finishing			
Natural gas ...	4.24	1.30	1.39	1.29	9.9	2.34	265
Fuel oil......	4.46	1.47	1.30	1.44	10.6	2.37	260

the head of the furnace. In the end of the caissons and in the middle vertical ducts under the working platform there are high-pressure burners; in the middle vertical ducts above the working platform there are low-pressure burners; the low-pressure gas is obtained by throttling a gas with a pressure of 2.5-3.0 atm.

There are measuring diaphragms in the gas pipes to the bottom burners in order to measure the amount of gas introduced into the vertical duct. The flow of gas through the burner at the end of the caisson is determined as the difference between the readings of the instruments from diaphragms 3 and 7 (Fig. 1). To control the amount of air entering the middle vertical duct, a gate valve was installed during the investigation. After determining the optimum cross section of the middle vertical duct, during repair the gate valve is removed and the duct is made with the necessary constant cross section.

The furnace was equipped with the appropriate control-measuring and regulating instruments.

The required rigidity and flatness of the flame are achieved by introducing compressed air along the sides of the gas stream through tubes fixed in the body of the caisson; it is also possible to feed compressed air from the top of the caisson.

Figure 2 shows the design of the head and vertical duct for firing a furnace with natural gas.

Introducing gas into the vertical duct through a high pressure burner did not give the required illumination of the natural gas flame; later, this burner was not used. When introducing gas into the vertical duct through a low-pressure burner the illumination of the flame was as good as that obtained by natural gas containing 30-40% fuel oil.

From the investigations satisfactory results were obtained for the operation of an open-hearth furnace using natural gas with a thermal arrangement shown in Table 1. The low-pressure gas flow is 30-40% of the total amount of gas; the middle vertical duct takes 15-20% of the air.

The flow of compressed air brought into the caisson is 700-800 m^3/hr (NTP). The introduction of compressed air into the burner fixed at the end of the caisson to increase the kinetic energy of the gas stream lowers the illumination of the flame and from this point of view it is undesirable.

The data of Table 2 show that an open-hearth furnace operating from April 1959 on one natural gas has completely satisfactory results, being equally as good as that with fuel oil. The rather large consumption of fuel when firing with natural gas is due to the small weight of the charge in the furnace, which is due to the wide range of castings. The technical and economic indices for the furnace operation with natural gas will improve.

At the present time work is being carried out on the improvement and simplification of the design of the furnace heads for operation with natural gas with self-carburation and especially without water-cooled caissons.

MAGNESIA RAMMING MATERIALS WITH SINTERING ADDITIONS

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The use of induction heating for melting high-grade steels at high temperatures and in vacuum, and also with a gaseous atmosphere makes it essential to increase the life of the linings of induction furnaces. The lining should be refractory, slag-resistant and thermally stable.

Those most frequently used are magnesite and magnesite-chrome linings. They have sufficient slag-resistance but the magnesite lining sinters badly and is insufficiently heat stable. With magnesite-chrome lining there is a possibility of chrome transferring to the metal.

In a search for new and more stable compositions for ramming materials, tests were conducted under laboratory conditions on selected compositions of magnesia materials with ferrous and titanium-ferrous additions. The starting material for ramming the lining of crucibles was provided by metallic powders "Ekstra" and MPM and also treated magnesite-chrome roof components (table). The sintering addition was obtained by grinding several components together till they could pass through a sieve with 144 holes per 1 cm^2. The content of the fraction less than 0.088 mm in the sintering addition was 75-80%. The charge was moistened in one case with a sulfite-alcohol residual liquor to a moisture content of 4.0%, in all other cases it was moistened by a solution of magnesium chloride to a content of 2.5-3.0%. Tests showed that the magnesium chloride gives the highest plastic properties for the mass with comparatively low moisture. Furthermore, it gives the ramming material good strength both at ordinary and at high temperatures.

At first the coarse-grained component of the charge was moistened; after the addition of the fine-grain component the mass was carefully mixed. Before the crucible was rammed, the internal walls of the inductor were covered with asbestos sheet. The crucible was rammed in layers using rammers with flat and with sharp angled ramming ends. After the bottom of the crucible had been rammed, a metal template was placed in the furnace. To prevent the weak freshly rammed crucible from breaking and to ensure good sintering, in the first heat the template was left in the furnace. To provide good contact between the layers and to obtain a denser monolithic ramming, before each successive layer was applied, the upper part of the previous layer was loosened up.

The working layer of depth 10-15 mm was made the densest so that the working zone of the lining had a more or less constant volume. The rest of the lining was less dense. In this way a so-called "buffer layer" was formed, preventing the extension of cracks which form in the working layer of the lining. The high density of the working layer and the addition, ensuring sintering of the magnesite powder, hindered the penetration of components of the metal charge and slag into the lining.

Special attention was paid to the drying of the crucible, since the drying system determines the formation of cracks during the first heat. In the 40-50 kg furnaces, the crucible was dried for 2-2½ hr with a generator power of 15-20 kw. A temperature of up to 1600 - 1700° was aimed at for the first melt. Although the lining of the crucibles operated under heavy temperature conditions, under the action of slags, often containing fluorspar, after the first 2-3 heats it was in a satisfactory state; there were no deep cracks.

The strength of the crucible, especially the unsintered upper part is affected by mechanical action during crumbling of the "ridges" which usually form in the upper part of the crucible. To prevent both crumbling of the unsintered part of the lining and the material of the lining from entering the slag, a fractional charge should be loaded, and the upper part of the crucible should be molded and roasted separately, after which it should be placed on the rammed walls of the crucible, carefully covered with the appropriate mortar (magnesite, chrome-magnesite or chromite, depending on the material of the upper and lower parts of the crucible).

The crumbling of the lining during operation was studied on samples taken from the crucibles after wear. Chemical analysis shows that during operation the lining of the crucible reacts with the reagents in the melt, which means that there is a reduction in the magnesium oxide content and an increase in the content of silicon, iron, manganese and chromium oxides. Depending on the zone of the crucible and the steels smelted, the content of silica in the lining increases by 2-7 times the original value. After service, four separate zones can be clearly seen in the thickness of the lining, differing from one another in their color and density.

The following conclusions can be drawn from the tests of the service of magnesia materials with sintering additions.

Composition of Charge and Chemical Composition of Materials

Capacity of crucible, kg	Thickness of crucible walls, mm	Composition of charge, %	Chemical composition of mass, %									
			SiO_2	Al_2O_3	TiO_2	Fe_2O_3	FeO	CaO	MgO	Cr_2O_3	MnO	losses
40	30	Grade MPM magnesite powder (fract. 0-4 mm) - 90%; ground mixt. of magnesite (45%), open-hearth slag (45%), ilmenite (10%) — 10%	4.10	3.03	0.56	0.79	0.97	4.63	82.95	—	0.56	—
50	40	"Ékstra" magnesite powder - 90% ground mixt. of magnesite, electrical furnace slag and ilmenite (2.5:2.5:1.0) — 10%	4.17	0.52	0.45	4.88	—	4.29	85.85	—	—	0.13
150	50—60	"Ékstra" magnesite powder - 90% caustic magnesite - 6.6% (above 100%): ground mixt. of magnesite and ilmenite (4:1) — 10%	2.00	0.07	3.20	2.33	—	3.26	82.52	—	—	3.70
40	30	"Ékstra" magnesite powder - 90%, ground mixt. of crude dolomite, cinder (calc. to obtain dicalcium ferrite) — 10%	3.52	1.46	not determined	2.84	3.19	5.72	83.70	—	—	0.044
300	60—70	Magnesite chrome — 100%	3.40	6.52	—	9.29	1.22	1.25	62.99	14.20	0.23	—

1. The starting material for ramming crucibles should be the purer (in chemical composition) metallurgical powder "Ékstra," having less shrinkage.

2. For melting chrome steels, it is desirable to use the waste from magnesite-chrome roof brick after it has been used in steel furnaces.

3. The sintering additions should be any of the mixtures made up of ground components: a) magnesite, slag and titanium-magnetite concentrate (2.5:2.5:1), b) crude dolomite and scale calculated to obtain dicalcium ferrite, c) magnesite and titanium-magnetite concentrate (4:1).

4. The granular composition of the charge should be:

Fractions, mm	4-2	2-0.088	Less than 0.088
Quantity, %	45-50	15	35 - 40*

5. To protect the lining of the crucibles from sharp temperature fluctuations after the heat has been tapped and in the period between the melts it is advisable to use light lids for the crucible and to reduce the supply of water to the inductor after the metal is tapped.

6. The use of ramming magnesite materials with sintering additions increases the life of the lining of induction furnaces by 2-3 times.

* Including 10-15% sintering addition.

* * *

INCREASING THE OUTPUT OF SEMIKILLED STEEL

D. A. Smolyarenko

In March 1959 a conference was held in Moscow, attended by representatives from a number of national economy councils, steel plants and research institutes. The conference dealt with means of increasing the smelting of semikilled steel.

At the present time a large amount of metal work is made from ordinary carbon steel: girders, supports for high voltage transmissions, the frames of buildings and industrial equipment. For this purpose rimming steel grade 3kp is mainly used, and although it has fairly high ductility, it has comparatively low strength characteristics. Thus, according to GOST 380-50 the guaranteed yield point of this steel is 24 kg/mm^2 with a tensile strength of 41-43 kg/mm^2. Furthermore, rimming steel has no impact toughness at low temperatures. The use of killed steels for the more critical components and constructions involves overexpenditure of metal and ferroalloys.

The degree of deoxidation is the most important characteristic of steel. It determines the behavior of molten steel in the mold while it is setting and the quality of the

TABLE 1

Chemical Composition of Steels

Grade of steel	Content, %				
	C	Si	Mn	P	S
1 kp	0.06—0.12	<0.05	0.25—0.50	0.045	0.055
1 ps	0.06—0.12	0.12—0.30	0.30—0.50	0.045	0.055
2 kp	0.09—0.15	<0.05	0.25—0.50	0.045	0.055
2 ps	0.09—0.15	0.12—0.30	0.30—0.50	0.045	0.055
3 kp	0.14—0.22	<0.05	0.40—0.65	0.045	0.055
3 ps	0.14—0.22	0.12—0.30	0.40—0.65	0.045	0.055

ingot. A measure of the completeness of deoxidation is the concentration of oxygen dissolved in the metal, although in practice external indications are used: the intensity of gas evolution from steel during hardening, the tendency to growth or shrinkage and the shape of the head of the ingot. Depending on these factors, steels are separated into rimming, killed and semikilled.

Semikilled steels have the following advantages over rimming steels: 1) the yield of useful metal is 90% (for rimming steel it is 85%); 2) low segregation; 3) low residual content of deoxidants; 4) economic melting (the metal spends less time in the furnace than in the melting of rimming steels and during casting there is no need for hot tops).

However, semikilled steels have the following disadvantages: 1) poorer surface quality than rimming steels; 2) the deoxidation must be strictly controlled; 3) increased porosity of the metal.

The chemical composition of this type of steel varies widely (Table 1). The usual deoxidants for semikilled steel are blast furnace ferrosilicon, silicomanganese, specular pig iron and ferromanganese. The silicon content in the finished metal is as low as 0.1%. Table 2 gives the mechanical properties of rimming and semikilled steels, Table 3 gives the standards for impact toughness at 20°.

Certain types of semikilled steels can only be deoxidized in the ladle by aluminum (100-500 g/ ton ingots). Sometimes small amounts of ferrotitanium are added to the ladle as well as aluminum. Deoxidation is also carried out in the ladle with ferrosilicon and also in the mold with small additions of aluminum shot.

The conference heard a report by L. M. Efimov, President of the Council for the Technical Section of the Central Research Institute for Ferrous Metallurgy and Head of the Ingot Laboratory. He dealt with the production of semikilled steel abroad. The Vice-President of the Council of Ministers of the USSR, A. K. Pudnikov, reported on a recent visit of Soviet metallurgists to US plants and on the production of semikilled steel at these plants.

In the USA and the UK, semikilled steel is used to build bridges, high buildings, various types of constructions, including support constructions, in the production of strip, welded pipes, sheet, tinplate, nails, etc. At the Plant of

TABLE 2

Results of Tests on Rimming and Semikilled Steels

Grade of steel	Yield point, kg/mm² (not less than)	Breaking point, kg/mm²	Relative increase in length, %			Bending test in the cold state at 180°; (a) thickness of specimen, (d) diameter of chuck
			With breaking point, kg/mm²	δ_{10}	δ_5	
				Not less than		
1 kp	—	32—40	32—40	28	33	$d = 2a$
2 kp	19—22	34—42	34—42	26	31	$d = 0$
2 ps						
3 kp	21—24	38—47	38—40	23	27	$d = 0$
			41—43	22	26	
			44—47	21	25	
3 ps	22—24	38—47	38—40	23	27	$d = 0$
			41—43	22	26	
			44—47	21	25	

the United States Steel Company in Youngstown for the production of bolts by cold stamping, rimming steels are melted and covered by lids ("mechanically covered steels") with a carbon content above 0.15%. The melting of these steels comprises about 8% of all the steel production at this plant. The yield of billets from steel covered by lids at the Gary Plant is higher than the yield from rimming steel. At the plant of the United States Steel Company in Gary, the steels covered with lids are used for the production of thin sheet, tinplate, wire, structural rolled steel and nails, etc. Experience at the Gary Plant has shown that steels covered by lids differ in their reduced chemical heterogeneity, there is a greater yield of useful metal and reductions in the preparation of molds for the smelting. At the Gary Plant, they are considering the possibility of melting these steels with a carbon content up to 0.30%.

Because the surface of rimming steel is better than that of killed steel and the internal structure of killed steel is better than that of rimming steel, foreign plants are starting to cast steel for deep drawing in the rimming state with subsequent killing in the molds. These steels are called "chemically covered steels." To stop the formation and evolution of gases in the head of the ingot, aluminum or silicon are added (a short time after the end of casting). The stream of metal draws the deoxidant into the depth of the metal and the rimming is stopped. In the USA and the UK, where steel is almost exclusively top poured, the deoxidant is introduced into the molds.

Since the silicon increases the hardness and yield point, its content in steel for deep drawing should be as low as possible. It is recommended that killed and semikilled sheet steels, which require a certain hardness, should contain between 0.05 and 0.10% Si.

The delegates from plants, councils of national economy and institutes presented interesting reports on investigations which they have made and on industrial experience Recently, in Soviet Steel Plants the fraction of killed steel has increased from 49.2% in 1951 to 58% in 1958. Semi-

TABLE 3

Impact Toughness of Rimming and Semikilled Steels

Grade of steel	Rolled product	Position of specimen in relation to rolling	Diameter or thickness of the rolled material	Maximum impact toughness, kgm/ cm^2
kp, ps	Sheet	Across	To 20	10
			20—40	8
	Wide strip steel	Along	To 20	10
	Structural and profile steel	Along	To 40	12
kp, ps	Sheet	Across	12—20	8
			20—40	7
	Wide strip steel	Along	12—20	9
			20—60	8
	Structural and profile rolled steel	Along	12—25	10
			26—100	9

killed steel is produced in very small quantities.

Of particular interest was the change-over from rimming metal to semikilled metal for the production of furnace welded pipes at the Vyksunsk Steel Plant. The semikilled metal was obtained by deoxidation with aluminum, since the deoxidation by silicon reduced the weldability. The amount of aluminum introduced into the ladle was 800 g/ ton of steel. This type of steel has better mechanical properties than 3kp grade rimming steel.

After detailed discussion, the conference adopted a resolution calling for the most rapid extensive introduction of semikilled steels into production. For the period 1959-1960 this would require research and pilot plant work at a number of plants, the extent of which would ensure the development of the best technical variants for the production of semikilled steel.

It was decided to concentrate this work in the first place at the following plants: "Zaporozhstal'" "Azovstal'" Makeevka, Stalino, Enakiev, Transcaucasus, Magnitogorsk Steel Combine and the Kuznets Steel Combine.

The Conference recommended the speedy introduction into production of technical variants whose industrial testing gives good results.

The Conference requested the State Planning Office of the USSR to assist in putting into practice a number of organizational and technical measures on a nationwide basis.

* * *

INCREASING THE DURABILITY OF THE LINING OF CHARGING WINDOW LIDS

L. A. Malakhovskii and E. N. Leve

Alchev Steel Plant, Ukrainian Scientific Research Institute for Refractories

In the open-hearth shop of the Voroshilov Plant, the water-cooled lids of the charging windows of the open-hearth furnaces were previously lined with fireclay. This lining lasted 3-7 days. Under the action of slag at high temperatures and also mechanical blows during raising and lowering of the lids, the fireclay lining sweated and crumbled, which meant that water from the water-cooled equipment came into contact with the roof, thus reducing its durability. According to the data of the plant and the Kiev Polytechnical Institute, the heat losses through the roof were increased by $0.86 \cdot 10^6$ kcal/ hr, which is equivalent to an increase in consumption of ideal fuel by about 10 kg/ ton.

The Ukrainian Scientific Research Institute for Refractories recommended that the fireclay lining should be replaced* by ramming with air hardening reinforced chrome-magnesite concrete (Soviet Patent of A. A. Prigorov and E. N. Leve No. 114026 of November 14th, 1957).

The lids were rammed with a chrome-magnesite mixture (60% chrome ore and 40% magnesite powder) prepared by the K. Marx Refractory Plant.

The mixture is moistened with a sulfite-alcohol residual liquor of density 1.2-1.25 g/ cm^3 to a moisture content of 3.2-3.5%. The mixture has the following chemical composition, %:

SiO_2	Al_2O_3+TiO_2	Fe_2O_3	Cr_2O_3	CaO	MgO
1.4	13.42	11.58	25.0	1.48	44.25

The granular composition (% of fractions), mm:

Above 3	3-1	1-0.4	0.4-0.06	Below 0.06	Remainder
18.1	18.8	18.6	38.7	5.8	3.6

* The following helped in the work on the new method of lining: E. P. Dryapik, I. I. Nevedimov, and N. E. Surmin.

To make sure that the mixture sets, before it is used it is moistened with a magnesium sulfate solution of density $1.3\,g/cm^3$. The amount of solution used is 3-3.5 liters/100 kg.

Before ramming, the frame of the roof is cleaned of the old lining and to prevent the concrete mass from crumbling a border of sheet iron is welded round the inspection opening, the height of the iron being equal to that of the lining. The concrete mixture is rammed in layers by means of a pneumatic rammer. After it has been compressed, the ramming is reinforced with metal rods which are knocked into the mass in a staggered order. To reinforce the ramming of one lid, up to 150 bars of length 130-140 mm and 16-18 mm diameter are used. After setting and drying in air for 5-7 days, the lids with the rammed lining are put on the furnace.

The durability of rammed reinforced concrete linings is between 25 and 33 days, which is about 5-7 times that of fireclay linings.

Considerable savings can be achieved in the use of rammed linings in the production of concrete mixtures by using the procedure of the Refractories Institute. This allows the maximum use of magnesia refractory waste and the centralized supply of concrete mixture to the steel plants.

THE PRODUCTION OF COLD-ROLLED DYNAMO STEEL

V. Kh. Faizullin

Director of the Sheet-Rolling Group, Central Factory Laboratory of the Magnitogorsk Metallurgical Combine

The Magnitogorsk Metallurgical Combine was the first in the country to organize the production of cold-rolled dynamo steel, which has a number of advantages over the hot-rolled product. Dynamo steel has the following chemical composition, %:

C	Si	Mn	S	P	Cr	Ni	Mn
0.04–0.06	1.2–2.0	0.25–0.40	$\leqslant$0.025	<0.03	$\leqslant$0.05	$\leqslant$0.05	$\leqslant$0.15

Steel with a silicon content of 1.2-1.7% is intended for grades Ė1100 and Ė1200, and that with a silicon content of 1.8-2.0% for grade Ė1300.

At the Magnitogorsk Metallurgical Combine, cold-rolled dynamo steel is produced in the form of sheet with dimensions 0.5×670×1430 and 0.5 × 750 × 1500 mm; the first is produced from slab 115 × 740 × 4200-4500mm and the second from slab 110 × 810 × 4200-4500mm. The slabs are rolled from a big-end-up ingot weighing 7.4 metric tons, having a lower section of 810 × 5600 mm and an upper section of 850 × 610 mm, the height of the ingot (without the extension piece) being 1900 mm.

The technical details of the production of cold-rolled dynamo steel sheet were worked* out taking into account the special properties of the blooming equipment and of the sheet-rolling mills at the Magnitogorsk Combine.

The ingots are heated in regeneratory soaking pits, fired principally by blast-furnace gas (in the first period, to accelerate the heating, a mixture of coke-oven and blast-furnace gas is sometimes supplied). When the ingots are placed in the soaking-pits, they have a surface temperature of 600-800°C. The time taken in heating depends on the temperature of the ingots (as measured with an optical pyrometer) before they are placed in the compartments. Thus, if the surface temperature of the ingot is 700°C the time taken in heating is 5 hours, 20 minutes. Seven to eight ingots are placed in one compartment for heating. Uniformity of heating is achieved by turning the ingots through 180° about their longitudinal axis and by soaking them at the determined temperature for 1-1½ hours. The temperature of the ingot before rolling is comparatively high (1280-1320°C). This is necessary so that rolling the dynamo steel may be completed at a higher temperature when the metal still retains good plasticity: in this way, overloading the blooming equipment, in particular the shears, is avoided.

The ingots are rolled down to a thickness of 125 mm in two blooming mills placed in sequence, having roll diameters of 1100 and 1150 mm, corresponding to 9 and 11 passes. Then the billet is placed under the shears to remove the head (14%) and the tail (2.5%). The slabs are rolled down to their final thickness (115 or 110mm) in three stands placed one after the other, of which the first two have roll diameters of 660 and 550mm (horizontal), and the third 410 mm (vertical). A pair of parallel-positioned shears is provided to cut the billet off into slabs of the required length.

After cooling, the slabs are inspected and any existing defects are removed by flame-scarfing. Observations have indicated that the surface of the slabs is affected chiefly by scabs (50-60%), working cracks (20-35%) and longitudinal seams (10-15%). Scabs most frequently occur in slabs corresponding to the tail of the ingot, and seams in slabs from the head of the ingot. If cuffs in the form of open rectangular boxes made of plain carbon steel sheet 0.4-0.5 mm thick are used in casting the steel into the ingot-molds, the number of surface scabs is considerably decreased and the productivity of surface-scarfing workers is increased approximately by a factor of two.

Hot-Rolling

Before rolling into strip in the continuous thin-strip mill 1450, the slabs are heated in three-zone continuous furnaces of the recuperative type. The welding zones of the furnaces are fired by black oil, and the soaking zones by a mixture of blast-furnace and coke-oven gas. The temperature in the welding zones is maintained in the range 1330-1350°C, and in the soaking zones 1280-1310°C. The usual time taken in heating the slabs in the furnaces is not less than 1 hour, 30 minutes.

Mill 1450 consists of 10 working stands, placed consecutively, of which the first four are roughing stands, and the last six form a continuous finishing group. The diameter of the working rolls of the first (broadside) stand of the mill is 900 mm with backing rolls of 1320mm; the second and third stands (two high) have rolls of 850mm diameter. The last seven stands are four high with working rolls 500mm and backing rolls 1100mm in dia-

*G. G. Kustabaev, R. A. Zaitsev, V. V. Kashintsev, V. A. Sokolov and M. E. Babushkina took part in this work.

meter. The three roughing stands (2,3 and 4) are, moreover, equipped with vertical rolls. In front of the broadside and the first finishing stand are situated scalebreakers (two-high stands) with roll diameters respectively 800 and 600 mm. Each stand is powered by an individual electric motor.

In the four passes in the roughing stands a billet 19-20mm thick is obtained from the slab of dynamo steel, and this is then rolled down to a thickness of 2.4mm in the six passes of the stands of the finishing group. During rolling, scale is removed with water under a pressure of 75 atmospheres after the roughing scalebreaker, after the second roughing stand and after the finishing scalebreaker.

The temperature of the billet after the fourth stand of the roughing group varies in the range 1100-1130°C, and with a rolling speed in the last stand of the finishing group of 330-350 m/ min, the temperature at the end of rolling lies in the range 840-900°C. The strip, coiled into reels, is transferred to a chain-conveyer leading by a closed tunnel to the coil storage house of the sheet shop.

Initially, rolling was carried out on mill 1450 at a much lower temperature (the temperature at the end of strip-rolling was around 820°C) down to a hot-rolled strip thickness of 2.2mm. Under these conditions a number of difficulties were encountered, especially in rolling slabs 810 mm wide. It was found that, in rolling dynamo steel, the motor loads were 40-50% higher than the corresponding motor torques in rolling plain-carbon steels of the same dimensions. Rolling dynamo steel was accompanied by considerable overloading of the motors and other equipment, especially of the finishing stands, which led to more frequent roll breakages in the mill.

Standard rolling of dynamo steel in the continuous mill was organized only after thorough investigations, as a result of which the heating schedule for the slabs and the temperature and thickness of the billet entering the finishing group were strictly regulated, and the thickness of the hot rolled strip was increased from 2.2 to 2.4 mm.

The cold reels of dynamo steel (without black annealing) are placed in a continuous etching apparatus to clean off scale from the steel surface with a sulfuric acid solution. The reels are unwound and the ends of the strip welded together in a welding machine.

The strips pass through four etching and two washing baths. The cascade method of etching used in this line makes it possible to achieve a good surface with a strip speed of 50-55 m/min. In this method of etching, the variations in the concentration of the etching solution are very small, because of the continuous addition of fresh etching solution into the fourth bath, from which it flows into the preceding baths through a tube joining the etching baths. Similarly, spent etching solution spills out continuously from the first bath. Slime is removed from the surface of the etched strip by metal brushes in a cold washing bath. After hot washing and hot-air drying, 15-20 mm are trimmed off the longitudinal edges of the strips with disk shears, the strips are greased with spindle oil and wound into coils weighing about 9 metric tons.

Cold-Rolling.

The cold-rolling of the dynamo steel strips down to a thickness of 0.5 mm is carried out in the continuous 5-stand mill 1200, having working rolls of 500 mm and backing rolls of 1300 mm diameter. The mill is equipped with individual drive for each stand from direct current electric motors. The first and second stands have a single electric motor each, and the third, fourth and fifth have two each.

The leading edge of the strip is rolled at the feeding-in speed and then the mill is switched to the working speed (14-15 m/ min). An emulsion is used for lubrication and cooling.

The continuous rolling of dynamo steel at high speeds and comparatively high reductions (Table 1) can be successfully carried out only with good quality hot-rolled strip; this calls for constant attention to the casting technique, and to the preparation of the slabs and rolled material for the cold-rolled sheet.

The coils are annealed in three section bell furnaces, the length of the working volume being 7770 mm, the width 2900 mm and the height 3940 mm. For each furnace there is one bell with 28 high-pressure injection burners and 9 muffles of stainless steel 1Kh18N9T (muffle diameter 2000 mm). The furnaces are heated with a mixture of blast- furnace and coke-oven gas. To protect the metal from oxidation, a neutral gas is introduced under the muffle, obtained by burning a blended gas with a surplus air coefficient of 0.9 and purified from hydrogen sulfide and carbon dioxide in a special installation. The coils are placed in four layers, two rows to each base-stool of the stand (the weight charged is about 65 metric tons). The heating temperature for the first anneal is 880-930 °C (for 12 hours) followed by cooling under the bell to 650 °C and under the muffle to 200 °C. Annealing usually takes about 50 hours.

A disadvantage of annealing in coils at high temperatures is that the coils warp and flatten. In the initial period of rolling development (up to introducing into the schedule the technique of temper-rolling and the second anneal) the electromagnetic properties of the steel were low. Thus, in October and November 1956, rejects

TABLE 1

Schedule of Reductions in Rolling Dynamo Steel in the 5-stand Mill.

Stand	Strip thickness on entering stand, mm	Strip thickness on leaving stand, mm	Absolute reduction, mm	Percentage reduction, %
1	2.40	1.75	0.65	27
2	1.75	1.15	0.60	34
3	1.15	0.80	0.35	30
4	0.80	0.58	0.22	27
5	0.58	0.50	0.08	14

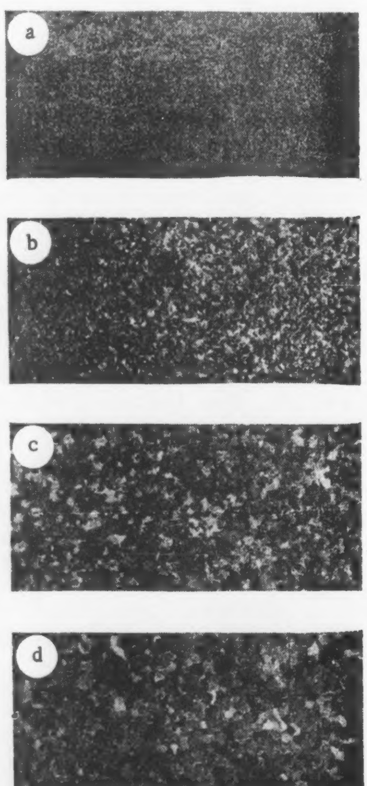
from this cause were 30-40%. The consumption coefficient of metal for 1 metric ton of final sheet was 1.5-1.6 from the hot-rolled coil.

After introducing a temper-roll in a two-stand mill of 1200 mm and a second low-temperature anneal into the production technique for the cold-rolled steel, a marked improvement in the electromagnetic properties of the steel was achieved, and the consumption coefficient of the metal from the coil was reduced to from 1.17-1.20.

To produce tension during the temper-rolling, the mill is equipped with fore- and back- tensioning rolls of 500 mm diameter. Each working roll has independent drive from two electric motors of 180 kw power. Two electric motors are installed to drive the fore-tensioning rolls (one motor to each roll). The back-tensioning rolls are driven by four electric motors (two to each roll).

The reductions during the temper-rolling of dynamo sheet are kept in the range 2.0-3.0%. In Table 2 results are shown for the magnetic properties before and after temper-rolling with various reductions and final low temperature annealing. The second low-temperature anneal is introduced not only to eliminate hardening produced in the sheet during the temper-roll, but also to obtain a coarser grain-size in the previously deformed metal.

After annealing, cold-rolled dynamo sheet as a rule has a fine-grained structure, but after the deformation and the second anneal the grain-size increases (see figure). This also explains the reduction in the specific losses of the metal. In addition minimum variation in the thickness of the sheet is achieved by temper-rolling (the variation in thickness does not exceed 0.015 mm).



The structure of dynamo steel depending on the degree of reduction in temper-rolling. a) Without temper-rolling; b) Temper-rolled 2%; c) Temper-rolled 3%; d) Temper-rolled 3.5%. (Second anneal as coiled at 700-750° C)

TABLE 2

Magnetic Properties of Dynamo Steel before and after Temper-Rolling with Various Reductions

Melt	Si, %	Reduction %	Magnetic Properties		
			P_{10}* w/kg	P_{15} w/kg	B_{25}, gauss
a	1.57	0.0	3.09	6.65	16300
		1.5	2.79	5.50	16000
		3.0	2.02	4.20	15700
b	1.42	0.0	3.08	6.50	15550
		2.0	2.41	5.46	15500
		3.0	2.32	5.46	15400
c	1.55	0.0	2.92	5.96	15990
		2.0	2.05	4.42	15600
		3.0	1.98	4.30	15600
		3.5	1.94	4.19	15600
d	1.57	0.0	3.01	5.98	15800
		2.0	1.98	4.16	15500
		2.5	1.97	4.17	15450

* In Table 2 and succeeding tables the headings $P_{10/50}$ and $P_{15/50}$ signify the watt loss at 10 (or 15), 000 gauss, 50 cycles/sec in w/kg.

The second low-temperature anneal is carried out according to the following schedule: the temperature of heating is 700-750 °C, and the metal is held at this temperature for 12 hours and allowed to cool to 200 °C under the muffle. Annealing usually takes about 40 hours. After annealing, the coils are treated in a continuous slitting unit where they are unwound into strip, up to 15 mm is trimmed off the edges, the strip is cut into measured lengths and sheets are taken for determination of electromagnetic and plastic properties. Then, according to the test results, a particular grade is allocated to the cold-rolled sheet.

From the test results on 545 production batches made according to the technique adopted at the Magnitogorsk Combine, the dependence of the magnetic properties of cold-rolled dynamo steel upon silicon content was established (Table 3). An idea of the level of the magnetic

TABLE 3

Dependence of the Electromagnetic Properties of Cold-Rolled Dynamo Steel on Silicon Content

Silicon content, %	No. of batches tested	Magnetic properties		
		B_{25} gauss	$P_{10/50}$ w/kg	$P_{15/50}$ w/kg
0.9—1.2	16	15700	3.09	6.55
1.21—1.30	54	15600	3.05	6 35
1.31—1.40	74	15700	2.98	6.10
1.41—1.50	79	15800	2 70	5.67
1.51—1.60	123	15700	2 62	5.54
1.61—1.70	152	15560	2 53	5.28
1.71—1.80	19	15780	2 22	4.82
1.81—1.95	28	15700	2.17	4.61

TABLE 4

Output of Various Grades in May and April 1959

Month	Grade	% of total	Month	Grade	% of total
April	É1100	7.4	May	É1100	4.0
»	É1200	25.9	"	É1200	20.0
»	É1300	66.7	"	É1300	76.0

TABLE 5

Influence of Annealing Temperature on the Magnetic Properties and Grain-Size of Dynamo Steel Containing 1.67% Silicon

Annealing tempera-ture °C	Magnetic properties			A.S.T.M. grain-size
	B_{25} gauss	$P_{10/50}$ w/kg	$P_{15/50}$ w/kg	
650	16490	4.10	8.72	8
700	16520	3.5	7.38	—
750	16550	2.95	6.16	7
800	16400	2.71	5.80	7
850	16500	2.89	6.00	7–6
900	16400	2.74	5.73	7–6
950	16150	2 46	5.64	7–6
1000	16100	2.36	5.27	6–4
1050	15600	2.14	5.07	5
1100	15300	2.20	5.89	5–4
1150	11500	2.38	5.98	4–5

properties may be gained from the output of the different grades in May and April 1959 (Table 4)

Workers in the heat-treatment laboratory at the Centra Factory Laboratory (M. I. Kolov and G. I. Terekhova) have studied the influence of annealing temperature on the magnetic properties and grain-size of dynamo steel. The experimental anneals were carried out at every 50° in the temperature interval 700-1150°C. The specimens were held at each temperature for 6 hours, and then cooled in the furnace to 500° at the rate of 20-30°C/hour. Further cooling of the boxes was carried out in air (annealing was carried out in laboratory furnaces and the specimens

TABLE 6

Influence of Annealing Temperature on the Magnetic Properties of Dynamo Steel

Annealing tempera-ture °C	Duration, hours	No. of batches	Average value of magnetic properties		
			P_{10}	P_{15}	B_{25}
770–820	24	2	3.55	7.28	15765
825–875	24	20	3.32	6.80	15850
850–900	24	5	3.12	6.23	15950
900–950	24	6	3.05	6.14	15735
900–950	12	6	3.09	6.30	15995
875–925	12	40	3.15	6.38	15840

TABLE 7

Influence of the Time Held at Temperature in the Annealing of Dynamo Steel on Its Magnetic Properties (Annealing temperature 900° C; annealing carried out in laboratory furnaces)

Time, hours	B_{25} gauss	$P_{10/50}$ w/kg	$P_{15/50}$ w/kg	A.S.T.M. grain-size
2	16050	2.89	5.96	8
3	16350	2.86	6.06	7
4	16300	2.86	6.00	7
6	16300	2.61	5.70	7
8	16200	2.59	5.54	6–7
12	16150	2.53	5.5	7 4
18	16050	2.28	5.2	6–3
24	16000	2.18	5.03	6–3
36	15800	2.01	4.68	5–4–2
48	16050	2.03	4.75	5–3–2

TABLE 8

Influence of the Temperature of the Second Anneal on the Magnetic Properties of Dynamo Steel

Annealing tem-perature, °C	B_{25} gauss	$P_{10/50}$ w/kg	$P_{15/50}$ w/kg	A.S.T.M. grain size
After temper-rolling before annealing	15900	4.27	7.80	—
650	16300	2.52	5.65	7
700	16200	2.38	5.36	7–6
850	16000	2.24	5.06	1

of dynamo steel were placed in iron boxes). As can be seen from Table 5, with increased annealing temperature the watt losses are reduced. This is explained by the considerable grain-growth –recrystallization processes are more completely accomplished.

Experimental anneals, made under factory conditions at every 50° in the interval 770-950°C, the time at temperature being 24 and 12 hours, confirmed the results obtained under laboratory conditions (Table 6). By far the lowest values of specific losses were obtained after annealing at 900-950°C for 24 hours. With this annealing temperature, however, coils were found to stick together.

In Table 7, results are shown on the influence -on its magnetic properties of holding time during the annealing of dynamo steel with a silicon content of 1.68%. A reduction in watt losses was observed on holding up to 36 hours.

The influence of the temperature of the second anneal on the magnetic properties of dynamo steel containing 1.69% silicon (temper-rolled with a reduction of 1.5-2.0%) is shown in Table 8.

Cold-rolled dynamo sheets, prepared at the Magnitogorsk Combine are notable for increased plasticity (a specimen can endure more than 40 reversed bends) and for dimensional accuracy; they do not exhibit camber or waviness.

THE DESIGN OF THE FINISHING ROUND PASS

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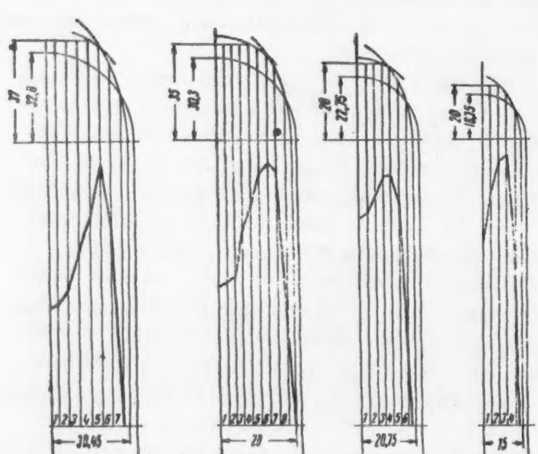
Nowadays round section is, as a rule, rolled from an oval, nearly elliptical, section. In our experience we have met with some difficulties in obtaining an accurate circular shape. Usually the diameter through the section at an angle of 45° to the horizontal is larger than the vertical and horizontal diameters (the round "with shoulder"). This is caused by the displacement of the rolls relative to the vertical axis of the pass, and of the guides relative to the central line, by a more severe wear of the groove in the places located at an angle of 45° to the horizontal, and by variations in the distance between the rolls.

The first two causes can easily be eliminated by a correct adjustment of the mill.

To obtain a correct circular section, one makes the distance between the rolls either smaller or greater than the design value, depending on the "springiness" of the stand. When the distance between the rolls is reduced or increased, the vertical diameter (axis) of the round pass is reduced (or increased) by the same amount. At the same time, the diameter (axis) inclined at an angle to the finishing pass becomes larger than the vertical diameter. The horizontal diameter remains constant. The horizontal width of the round section is controlled by the thickness of the prefinishing oval section.

In our investigations, the templets of 65, 60, 45 and 30 mm diameter round sections were superimposed on the finishing pass (circular) and, after the oval and round sections had been split into several parts, the natural draft for each part was calculated. In this way, it was confirmed that the maximum draft takes place in that part of the pass which is located at an angle of approximately 45° to the horizontal and this is, we think, the cause of the intense wear of the grooves in these places (Fig. 1). The actual natural drafts for each part of 65, 60, 45 and 33 mm rounds are given in the table.



a b c d

Fig. 1. Curves indicating the natural drafts in the finishing pass during the rolling of round sections of various diameters, mm: a) 65; b) 60; c) 45; d) 30.

Actual Drafts During the Rolling of Round Sections, mm

Diameter of the round section, mm	Passes							
	1	2	3	4	5	6	7	8
65	1.13	1.135	1.15	1.193	1.235	1.295	1.22	—
60	1.155	1.158	1.169	1.230	1.250	1.280	1.290	1.278
45	1.230	1.235	1.253	1.276	1.276	1.220	1.060	—
33	1.20	1.236	1.288	1.300	1.220	—	—	—

In order that as it wears the round pass should approach a regular circle, we proposed a design of the round pass in which the diameter passing at 45° to the horizontal is the smallest. To construct the finishing round pass one has to draw perpendicular axes AD and BC (Fig. 2) and then draw lines Ne and MK at an angle of 45° to AD and BC. Arcs of a radius $R = R_{max} + x$ are drawn as follows: arc De from point O_1, arc MA from point O_2, arc AN from point O_3 and arc DK from point O_4.

It is assumed that the maximum radius of the constructed circle is:

$$R_{max} = \frac{d + \Delta m}{2} \cdot 1.013,$$

where $+\Delta m$ is a positive tolerance.

The minimum radius of the constructed circle is

$$R_{max} = \frac{d - \Delta m'}{2} \, 1.013,$$

where $-\Delta m'$ is a negative tolerance;

$\underline{d}$ is the nominal diameter of the round section.

The $\underline{x}$ and $\underline{y}$ coordinates of the points O_1, O_2, O_3, and O_4 are equal to each other; they are determined by

the condition that Ne and MK are equal to the minimum diameter of the round section in hot condition.

In accordance with our assumptions we obtain from Fig. 2

$$R_{min} + \sqrt{y^2 + x^2} =$$
$$= R_{max} + x \text{ (assuming } \; x = y);$$
$$R_{min} + 1.41x = R_{max} + x.$$

Denoting $R_{max} - R_{min} = \Delta s$, then

$$x = y = 2.43\,\Delta s.$$

With radius R, arc Me from point $\underline{n}$, and arc NK from point $\underline{n}_1$ are drawn. Points $\underline{n}$ and n_1 can be determined by marking off distance R from points $\underline{e}$ and N to the intersection with line BC.

The distance R in Fig. 2 can be determined by the equation:

$$(R-b)^2 + a^2 = R^2;$$
$$b = R_{min} - R_{max} \cdot 0.7071 +$$
$$+ 0.2924\,\Delta s = R_{max} 0.2929,$$
$$a = 0.7071 R_{min}$$

In the solution of equation $(R-b)^2 + a^2 = R^2$ the term $\frac{0.8535\Delta s^2}{R^2}$ is neglected as very small (its

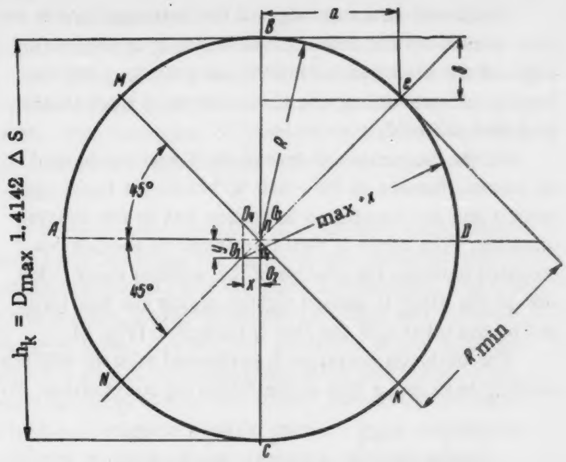


Fig. 2. Construction of the finishing round pass.

magnitude is of the order of hundredths of a millimeter) and then

$$R = R_{max} - 1.7\Delta s^2.$$

It is accepted that the height of the pass is

$$h_k = D_{max} - 1.4142\Delta s.$$

A trial production of round sections at the Stalino Metallurgical Factory has shown that the proposed design of the finishing round pass is quite justified; the accuracy in the section dimensions has improved and the service life of the grooves has increased.

* * *

INCREASING THE SERVICE LIFE OF BLADES FOR HOT METAL CUTTING

L. N. Gorodetskii, Assistant Head of the Rail-Structural Shop
L. S. Zadorozhnyi, Shop Foreman, and R. M. Shereshevskaya, Senior Engineer of the Works Laboratory
Petrovskii Works

The blades for 250 ton hot-cutting shears at the rail-structural shop of the Petrovskii Works were initially made from forged steel 6KhN1M and U7-U8. The shears were used for cutting square sections (120 × 120 mm and 140 × 140 mm) of steel grades St. 0 to St.3 at 600 - 800°C. The average service life of the shears was 56 hours, all four edges of the blades being utilized.

The short service life of the blades for hot steel cutting is due to severe operating conditions; the cutting edge becomes very hot and is rapidly cooled with water. As a result, numerous cracks appear on the cutting side of the blade and it begins to crumble away (Fig.1). Increasing the durability of the blades by building up their sides with Sormite No. 1 alloy did not produce any noticeable effect, probably because of considerable fluctuations in the temperature of the blade sides during service.

A considerable improvement in the service life (up to 312 hours) of the blades is achieved by the automatic building up of the edges with welding wire Sv.08 or Sv.08A with the use of a ceramic flux as introduced at the "Azovstal'" Works.

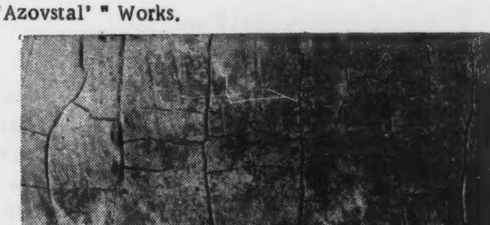


Fig. 1. The cracked side of a knife.

At the rail-structural shop of the Petrovskii Works we have introduced the technique of building up the cutting edges of the blades with 3Kh2V8 alloy steel. After the forging and machining, the blades made of steel 45 are annealed at 810°C.

For the prevention of cracks the blades are heated in an electric furnace to 350 - 400 °C before the build-up process and are transferred in an iron box to the welding machine. The blade is then transferred to another box mounted between the clamps of the welding stand. One side of the blade is pressed tightly against the box wall and on the other side the flux is packed in (Fig. 2).

The build-up operation is performed with an ABS type welding head and a flux of the following composition, %:

SiO_2	Al_2O_3	CaF_2	MgO	CaO
19-24	27-32	25-33	9-13	3.0-9.0

K_2O	FeO	MnO	S	P
	Maximum			
2.4-3.0	1.0	0.5	0.08	0.05

The moisture content of the flux should not exceed 0.1%. Powder wire PP3Kh2V8 is used as the electrode for building up the blade edges.

The welding regime is as follows: current 420-450 amp; dc of reverse polarity; arc voltage: 32 - 34 v; speed of arc displacement: 22 m/hr; rate of wire consumption: 56 m/hr.

The rate of wire consumption is controlled by re-setting the change wheels and it can be varied within the range of 28.5 to 255m/hr.

The current is determined by the rate of feeding the wire and by the diameter of the wire.

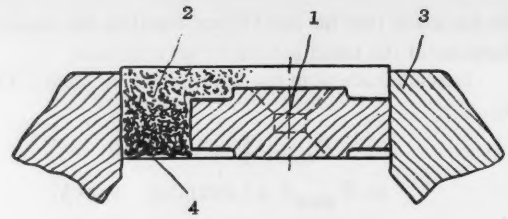


Fig. 2. A method of mounting the blade before the building up of alloy layer:1) blade; 2) flux; 3) clamps; 4) box.

After it is built up, the blade is placed in a furnace at 400°C, it is kept at that temperature for 30 minutes and then slowly cooled in the furnace. The blade is then tempered at 300°C for 2 hours. The built-up metal has a troostite-martensite structure with a smooth transition to a pearlite-ferrite structure of the base metal.

After the tempering, the blade is polished and sharpened. The hardness of the thermally treated built-up edges lies within the range of 45 - 49 R_C. The built-up metal has the following chemical composition, %:

C	Mn	Si	Cr	W	V	S
0.29	0.89	0.92	2.5	9.37	0.33	0.030

The average service life of the blades is 498 hours.

Out of eight built-up blades which were in service in 1958, not a single one went out of service on the grounds of the poor quality of welding (breaking or wear of the built-up layer). The use of blades with built-up cutting edges made it possible to reduce the consumption of blades by a factor of 30.

* * *

AN IMPROVEMENT OF THE HEATING FURNACE OF THE MOVEABLE TUBE-WELDING MILL

E. M. Tsygankov, Chief Plant Engineer and M. S. Garkusha, Senior Engineer of the Furnace Laboratory

Vyksun Metallurgical Plant

When producing welded tubes by the noncontinuous method on moveable mills, the wastes along the front ends due to nonfusion are 9-11%(for 400-500 mm lengths), which is caused by the suction of air and a certain decrease in the heating temperature in this section of the furnace.

The investigations which we conducted at the plant* showed that the requisite condition for obtaining a quality joint in furnace-welded tubes is to attain a temperature of 1370° for the metal at the moment of welding, i.e.,the melting point of ferrous oxide. At lower temperatures the ferrous oxide, which is in a solid state, inhibits weldability and thus sharply decreases the joining and reaction between the surfaces being welded.

* N. A. Titov, P. V. Timofeichev, Ya. S. Zimin, K. I. Petrov, G. A. Rachkov, M. S. Golyshkov, and L. M. Vladimirov participated in this work.

Comparative Data of Technical-Economic Operational Indices of the Moveable Mill

Indices	Before remodeling furnace	After remodeling furnace
Hourly productivity, m/hr	8.34	8.98
Output of serviceable tubes, % . .	88.42	88.96
Expenditure of conventional fuel, kg per 1 m of serviceable tubes.	121	113
Number of installed strips (pieces) on the furnace hearth for tubes with diameters, in inches:		
3/4	20	24
1	18	20
$1^1/_4$	15	18
$1^1/_2$	13	15
2	12	13

A shortcoming of welding furnaces operating on fuel oil is the presence from each side of the furnace of two regenerative chambers for heating the air. During operation, each of the chambers very frequently has, for different reasons, different heating temperatures which adversely affect the heating system of the furnace, the productivity of the mill, and makes it necessary to have twice the number of reversing apparatus and flues for them.

When the shop was shut down for major repairs the welding furnace was remodeled. The width of the hearth was increased from 2800 to 3000 mm. Instead of four regenerative chambers, two with the former volume were left. Instead of 22 inclined conduits each with a cross section of 350 x 185 mm, 11 vertical conduits each with a cross section of 550 x 300 mm were installed. In the front and back sections of the furnace, conduits of 550-525 mm each were made in order to improve the removal of gases and to eliminate the formation of crusts. The formation of crusts was not observed during the operation of the furnace with the enlarged vertical conduits.

In the central section of the furnace, brick columns were installed along the entire length under the central bottom beam which kept the beam from sagging. The crown of the furnace, in order to increase strength and decrease the heat losses, was laid out according to the "Ort" system – a ring of 380-mm Dinas brick was installed per each two rings of 300-mm brick. Horizontal conduits, which join with the vertical conduits were made every 300 mm in the damstone along the entire length at hearth level in order to improve the selection of the coldest gases. The gases together with particles of scale and slag can go from the furnace into the vertical conduits through openings in the damstone by changing only the direction of movement to a right angle.

It is apparent from the data given in the table that the operation of the furnace after remodeling is characterized by increased productivity and by reductions in metal and fuel expenditures.

A further reserve for improving the technical-economic indices for operating the moveable stands is by increasing the hearth length and heating strips together with a more complete utilization of the hearth width.

ECONOMIES IN FERROALLOYS WHEN WORKING AT THE LOWER LIMITS OF THE CONTENT OF ALLOYING COMPONENTS

M. Chekalkin and A. Sergushin

"Élektrostal' " Plant

The tasks of the Seven-Year Plan with regard to development of industry require a sharp increase in the production of special steels. The all round economy in the expensive alloying metals and alloys – chromium, vanadium, tungsten, cobalt, nickel, etc. – is extremely important for the national economy.

The presidium of the Central Committee of the Steel Workers Union has approved the initiative of the steel workers at the "Élektrostal' " Plant who have decided to work at the lower limits of content of alloying elements and have recommended that this technique be extended to other plants. The article published below gives the basic principles of the work of innovators at the "Élektrostal' " Plant.

At the end of 1957, steel workers of the Komsomol furnace of the electrosteel melting shop No. 1 of the "Élektrostal' " Plant, N. Morozov, S. Dubov, P. Gureev and A. Sergushin put forward the suggestion of making economies by producing steel at the lower limits of alloying elements. The masters of the electrical furnaces, V. Ushakov, N. Shershavkin, S. Glazkov and M. Chekalkin supported this idea and took upon themselves the task of directing the work. This was the start of considerable economies in materials at the plant.

The Komsomol electrical furnace specializes in the smelting of high speed steels types R18 and their substitutes R9. These steels contain tungsten, vanadium, molybdenum and other elements. The production of steel at the lower limits of alloying additions (especially tungsten) became possible due to improvements in the technique, the introduction of new methods, especially blowing the bath with oxygen during the melting of high speed steels and their substitutes.

As a result of the acceleration in the melting period, the melting time was reduced by 40-50 min the consumption of electrical power was cut by more than 20%, the waste of tungsten was reduced by about 30-10%.

Before the introduction of oxygen blast in the melting of high speed steel and their substitutes, much time and effort was wasted on dissolving the ferrotungsten which had settled on the hearth of the furnace. After the melt had been tapped, ferrotungsten was often left behind on the hearth. In these cases the content of tungsten increased during melting making it difficult to keep the steel within the required limits. In most of the melts the tungsten was in the upper limit.

The intensive boiling of the bath during the melting of high speed steels when using oxygen, the increase in the temperature of the metal due to oxidation, occurring with the evolution of heat create conditions for the rapid and complete fusion of difficultly fusible components of the charge, including the ferrotungsten which settles on the hearth of the furnace.

In most grades, the properties of steels do not depend on the content of the alloying elements providing this content does not go outside the limits laid down by GOST. A tool made of steel R18 with a tungsten content of 17.5% behaves the same in operation as a tool made from the same steel but containing 19% tungsten. In the second case, however, during melting a much larger amount of ferrotungsten is used.

The consumption of alloying additions (with respect to the content of the elements) is planned on the average limits. Consequently, if steel is produced at the lower limit with respect to tungsten, vanadium and other elements it is possible to achieve economies in the ferroalloys, thereby reducing the cost of 1 ton of steel. On the other hand, smelting steel at the upper limit of alloying additions leads to overexpenditure of ferroalloys and to an increase in the cost of steel. Beacuse of the specifications for work with molten metal and the insufficient accuracy of chemical analyses in rapid laboratory tests, the steel smelters usually calculate the alloying additions on the basis of the average limits. This is the best way of ensuring a given chemical composition.

In the change-over to the new method, extensive studies were made at all sections concerned with the melting of steel. The facts indicated that a new approach had to be made to all melting operations.

All the components of the metallic charge are now weighed accurately. The charging is supervised by the steel melter or the master. The steel melter supervises the arrangement of charge in the charging bucket, special attention being paid to the loading of ferrotungsten into the upper central part of the bucket so that the ferrotungsten in the furnace is in the zone of the arcs. The steel melter and the master supervise the helpers as they weigh out the ferroalloys.

The master calculates the charge so that during melting the correct contents are obtained for tungsten, vanadium, molybdenum and other elements at the lower limits.

Before charging, the steel melter and his helper carefully clean the hearth and the slopes of the furnace to remove metal and slag residues. Damaged spots are repaired with refractory materials. The hearth of the furnace should

be as smooth as possible since otherwise ferrotungsten can be retained by the irregularities. After charging, the steel smelter carefully examines the furnace and removes lumps of ferrotungsten from the slopes and baffle plate under the electrodes. The charge is melted at the maximum power of the transformer and after 60-80 min the molten metal is blasted with oxygen. After this a deoxidizing mixture is added to the bath in order to reduce a number of elements from the oxides which form due to the melting of the charge and blasting of the metal with oxygen. After 20-25 min the slag becomes bright. The bath is stirred several times to ensure that the steel has a uniform composition and a sample is taken for chemical analysis.

During the melting all additions of ferroalloys are carefully weighed. The ferrotungsten is added to the thoroughly deoxidized metal 40-50 min and the ferrovanadiur 30-40 min before the melt is tapped. After the ferroalloys have been added the bath is again carefullv stirred several times. The melt is tapped while the metal is thoroughly heated and the slag is white.

Success in the production of metal at the lower limit: of alloying additions therefore depends on the careful work of the steel melters, master, charge workers and the workers performing the rapid analyses in the laboratory.

The master calculates the economics of the new method. In a special logbook he records the date of the melting, the number of the heat, the grade of steel, the weight of ferrous ingots and the final number of the heat.

To facilitate calculations the engineering department of the plant together with the planning department have compiled a scale for determining economies or overexpenditure when melting steel with deviations of the contents from the average limits given in the table.

As an example, we will consider the economics of

Scale for Determining Economies and Overexpenditures when Deviating from the Average Limits of Contents

Deviation of the content of the element from the average limit, %	Cost, rubles/ton, of steel for the elements					
	W	V	Mo	Ni	Co	etc.
0,01	7	8	13	3	25	
0,02	14	16	27	5	50	
0,03	21	24	40	8	75	
0,04	28	32	53	10	100	
0,05	35	40	70	13	125	
0,06	42	48	83	15	150	
0,07	48	54	96	17	175	
0,08	55	62	109	20	200	
0,09	61	70	122	22	225	
0,10	67	80	134	25	450	
0,20	134	158	268	50	675	
0,30	200	238	402	74	900	
0,40	267	318	536	98	1125	
0,50	333	398	670	123	1350	
etc.						

the melting of R18 steel. We will assume that R18 steel is produced in a 5-ton batch and contains 18% W and 1.10% V. The average tungsten content for this grade is 18.25%, vanadium 1.20%.

The saving in tungsten will be (18.25 -18.00) × 5 t = 1.25% (125 hundredths).

The economy in vanadium will be (1.20 -1.10) × 5 t = 0.50(50 hundredths).

From the scale we find that the cost of 1.25% tungsten is equal to 832 rubles and the cost of 0.50% vanadium is equal to 398 rubles. For a given heat the total economy is 832 rubles + 398 rubles = 1230 rubles.

In the logbook these data are recorded in the following way:

Date	No. of heat	Grade	Yield of useful metal	Grade analysis, %		Economy, hundreds %		Over-expenditure hundreds %		Economy rubles	Overexpenditure, rubles
				W	V	W	V	W	V		
1/1 1959	00001	R18	5.0 tons	18.00	1.10	125	50	–	–	1230	–

In the logbook records are made of all heats melted at the furnace, regardless of the content of alloying elements. When the content of the element is above the average value, overexpenditure is involved which is subtracted from the total economy. When second grade metal or rejects are obtained for any reasons, the losses are also subtracted from the economy. The results of further operation in 1958 showed that the new method of smelting high alloy steel at the lower limits of the alloying additions can have a good economic effect.

During this year the economies in ferroalloys amounted to more than one million rubles. In 1959 the steel melters and masters of the electrical furnace set themselves a new target: to achieve an economy of 850 thousand rubles during the year. These tasks are being successfully accomplished During the 5 months of 1959 the economy was about 400 thousand rubles.

The steel melters of the Komsomol furnace have provided an example for the collectives of other furnaces. In this way, the electrical furnace steel workers are making an important contribution to the successful fulfillment of the Seven-Year Plan.

* * *

THE DEVELOPMENT OF FERROUS METALLURGY IN CHINA

A. B. Rozentreter

The Chinese people led by the Communist Party with the active help of the other Communist countries are successfully establishing an historic Socialist transformation.

Particularly important is the success achieved in China in the production of ferrous metals. In 1958 alone the steel output was more than doubled and exceeded 11 million tons. This is a remarkable development expecially taking into consideration the fact that in old China for almost half a century (1900-1948) only 7.6 million tons of steel were smelted altogether.

This tremendous increase in steel production is entirely due to the attention paid to this branch of industry by the Government. New production capacity has been put into operation, existing units have been redesigned and modernized, large deposits of metallurgical raw material and fuel have been explored. Three years after the new government took over, the production of iron and steel exceeded the highest level reached in old China in 1943 and in 1952 was 1.9 million tons of iron as compared with 1.8 million tons in 1943 and 1.35 million tons of steel as compared with 923 thousand tons.

The target of the first five year plan (1952-1957) for increasing the production of ferrous metals was achieved 13 months ahead of schedule. In 1956, 4.777 million tons of iron was smelted and 4.465 million tons of steel and in 1957 there were 5.898 million tons of iron and 5.350 million tons of steel. The average annual increase in steel smelting in the Chinese People's Republic between 1952 and 1957 was 31.7% whereas in the USA for the same period the average annual increase in steel smelting was 3.9%, and in Great Britain 5.7%.

There have been considerable improvements in the supply of raw materials in Chinese ferrous metallurgy. On the basis of data which are far from complete, the iron ore reserves were estimated at the end of 1958 to be 100 billion tons. In its iron ore reserves, China occupies the second place (after the USSR) in the world.

At the present time there are about 600 iron ore deposits in China. The most important of these are in the northeast in the region of the lower and middle sections of the Yangtse River, in inner Mongolia and in North China, on the island of Hainan, in the provinces of Hansu Tsinhai, Sichan, Futsyan, Shandun, etc.

In the northeast of the Chinese People's Republic in the regions of Anshan and Bensi during the first Five-Year Plan, new iron ore deposits were discovered which could supply the Anshan Steel Combine for 70 years with an annual smelting of 4 million tons of iron. It could also supply the steel plant in Bensi for about 100 years with an annual smelting of 1 million tons of iron. On the basis of the iron ore deposits found in the northeast, new ore plants, enrichment and sintering plants have been built, and the existing plants redesigned and extended. For example, an enrichment plant has been built at the Dagushan Ore Plant, an open-cut mine producing up to 7 million tons of ore per annum at the Dunanshan deposit, etc.

An iron ore deposit has been found at Baiyunebo (inner Mongolia); this can provide the steel combine which is being built at Paotow for 50 years with an annual output of 4.5 million tons of iron.

At the Dae deposit in the basin of the Yangtse River in the Hubei province, an ore plant is being built which can supply the Uhan Steel Combine which will shortly be put into operation.

In northwest China in the Hansu province, a large basin of high quality ore has been discovered. This will permit the development of a separate steel center in the northwest. Iron ore deposits have been found in the southwest and in other regions of the country.

A new iron ore region was recently discovered in the northern part of the Huichou Province. Geologists state that the total reserves here are about 10 billion tons, a large part of the ore containing more than 40% iron.

Iron ore deposits have also been found in the Daimeitsai Region (Henan Province). The total reserves of this deposit are estimated at 3 billion tons.

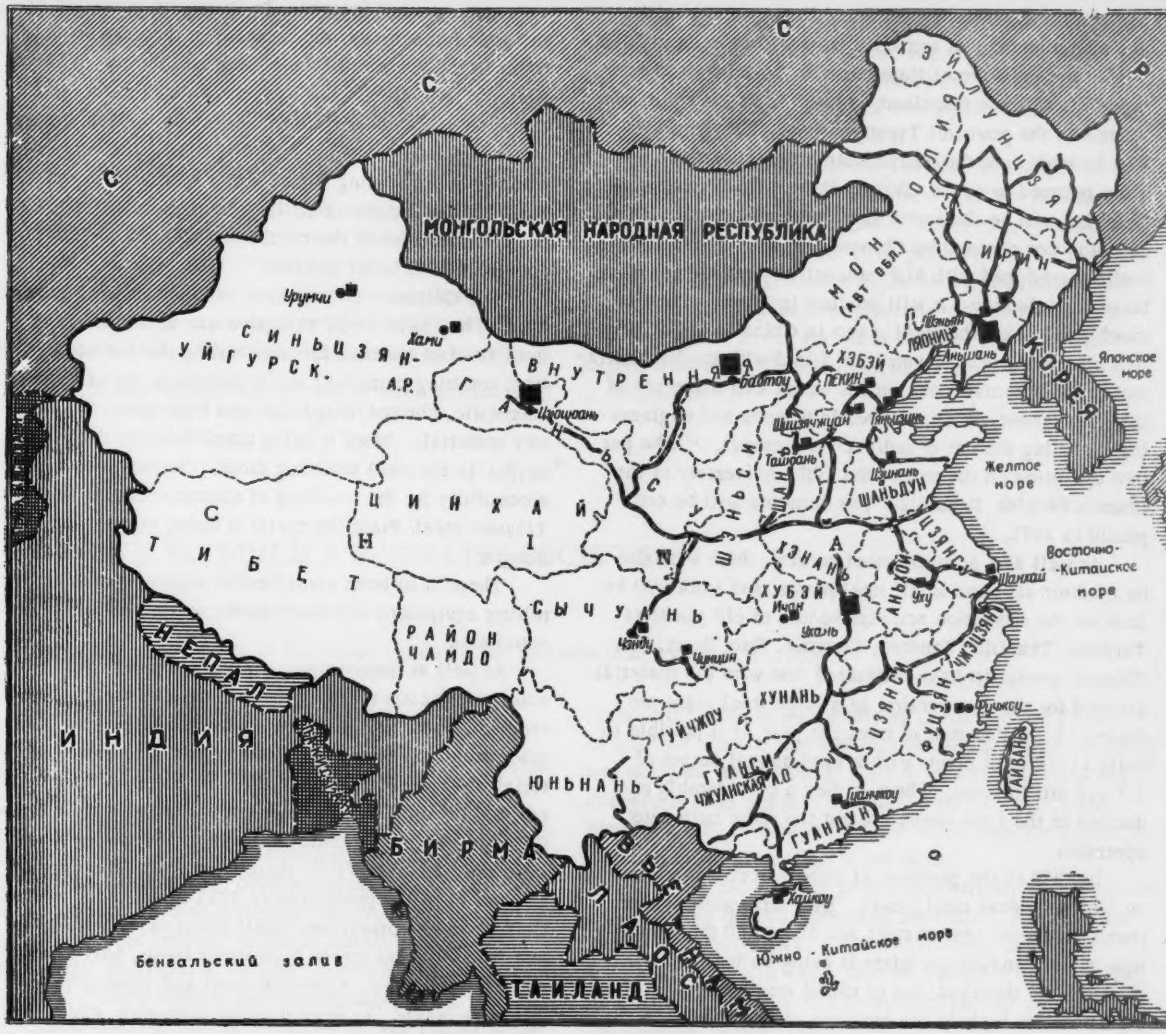
In 1958 deposits were found in the provinces of Tsyansi, Hubei, Yunnan, etc. The total reserves here are estimated at about 7 billion tons.

The largest deposits of coking coals in China were found in the province of Shansi where at the present time 13 new coal enrichment plants are being built. The production of coke in Henan Province in 1959 should reach 4 times the comparable figure for 1958.

One of the largest deposits of manganese ores in the world was recently discovered in the Hunan Province. New reserves of these ores have been found in the Province of Huandun and in the Huansi-Chuan autonomous region.

A large part of the production capacity in ferrous metallurgy is at the Anshan Steel Combine – the first steel center in China. At this center by the end of 1957, 40 new units had been put into operation, including a rail-structural mill, blooming mill, pipe rolling unit, 6 automated blast furnaces, 2 sheet mills, 4 automated jobbing mills, 10 open-hearth furnaces, 10 coke ovens, enrichment and sintering plants, 2 refractory shops. The result has been a 3-4 fold increase in output of ferrous metals at the Anshan Combine compared with 1952.

The No. 10 blast furnace was built at this combine in 1958; 5 open-hearth furnaces were put into operation,



Disposition of the Main Steel Centers in China

two of which have a charge of about 700 tons. Within the Anshan Steel Combine it has been decided to equip more than 200 medium and small blast furnaces of total capacity 4.5 million tons of iron and 50 average and small converters of total capacity 4.5 million tons of steel per year. Not far from the iron ore plants of the Anshan Steel Combine, medium and small steel plants are being built at the present time.

In April 1957, work was begun on the construction of the Uhan Steel Combine – the second steel center in the country – which will work on iron ores from the Dae deposit and coking coals from the Finfin, Pinsyan and Huainan deposits. The combine will consist of 18 main production units and more than 30 auxiliary shops.

The construction of Uhan Steel Combine will be completed in 1959. September 1958 saw the commencement of the No. 1 blast furnace with an output of more than 2000 tons of iron per day.

On July 14, 1959, the first heat was produced by the No. 2 blast furnace of capacity 700 thousand tons of iron per year. The furnace was built in record time – less than 5 months – as a result of the use of advanced methods of assembly. The construction workers are making every effort to get the basic production units into operation before the scheduled time. In this work they are being helped by Institutions from 47 cities in China and more than 200 Institutions in the Soviet Union.

The third large center for ferrous metallurgy in China will be the Steel Combine in Paotow (inner Mongolia) the construction of which was commenced in July 1957. In power it will be second after the Anshan Combine and in further development it will exceed its planned production capacity. At the Paotow Combine there will be 4 blast furnaces of up to 1513 m^3 capacity, a steel smelting shop with open-hearth furnaces with 250 and 500 ton charges, several rolling mills, coke oven and chemical plant, plant for refractory materials, enrichment and sintering plants, various maintenance and auxiliary shops.

The start of construction of blast furnaces and steel smelting shops and an ore plant in Baiyunebo, coke oven

and chemical plant, roughing and large jobbing mills, and also a number of auxiliary units will be seen in 1959.

In the province of Hansu near to Yuimin – the center of the Chinese petroleum industry – in 1958 work was started on the powerful Tsyutsyuan Steel Combine. It will be built near the Tsilyanshan Mountains which are often referred to as the Chinese Urals. The Tsyutsyuan Combine will be the fourth steel center in China. This combine was planned by Chinese engineers and will be entirely equipped with high productivity equipment of home manufacture. It will produce in 1 year almost as much steel as all the steel plants in China in 1957. The first blast furnace at Tsyutsyuan, fitted with modern instruments and automatic equipment which will make use of the most recent advances in world science and engineering including the use of radioactive isotopes, will be put into operation on the eve of the 10th anniversary of the Chinese Peoples Republic. The combine will be completed in 1962.

As well as 4 powerful steel centers, there will also be medium size and small steel plants, and work will be done on the expansion and redesigning of old plants at Taiyuan, Tyantsin, Tanshan, Chuntsin, Dae, Bensi, etc. Chinese specialists have estimated that with the material allotted for the construction of a large steel plant producing 1½ million tons of steel per year, it is possible to build 11-13 steel plants with a total annual output of 1.7-2.0 million tons. There is then a considerable reduction in the time needed to put the main units into operation.

In 1958 in the province of Hebei, work was started on 10 small local steel plants. They will produce more than 1.6 million tons of steel and about 500 thousand tons of iron. In Peking a plant is being built which will produce 200 thousand tons of rolled steel per year. New plants will be built in the province of Shansi near to the city of Yantsyuan and also near to Urumchi in the Sintsyan-Uigur autonomous region. In 1958 work was started on a new steel plant in the province of Tsilin (the city of Tunhua) calculated to produce 1.2 million tons of iron, 600 thousand tons of steel, 500 thousand tons of rolled material, 1.2 million tons of coke, and also 400 thousand tons of chemical fertilizer per year. The plant was designed by Chinese specialists. It will use equipment of home manufacture.

An important part in the successful expansion of Chinese ferrous metallurgy was the improvement in technical and economic indices for the operation of steel units and the introduction of improved working methods. During the first Five-Year Plan these improved methods led to a 34% increase in the smelting of iron and a 36% increase in the melting of steel.

For the whole of the country in 1957, the coefficient of utilization of useful volume for blast furnaces was 0.773 as compared with 0.970 in 1952, and the average daily output of steel from a square meter of hearth area was 7.10 tons compared with 4.78 tons.

An important factor in the improved operation of the blast furnaces was the increase in the proportion of sinter in the ore part of the charge and the use of fluxed sinter. The blast furnace workers of the Anshan Steel Combine achieved still better results by introducing the latest methods: constant humidity blast, smelting low-manganese iron, using fluxed sinter with high basicity, etc. The coefficient of utilization of useful volume at the blast furnaces of the combine was 0.685 in 1957 compared with 0.737 in 1956.

The Chinese steel smelters have obtained good results. They have made extensive use of fast smelting of steel and fast methods for overhauling the furnaces. The steel smelting units have made extensive use of basic magnesite, chrome-magnesite and high-alumina refractory materials. Work is being carried out on the use of oxygen in the steel smelting shops. Oxygen is being used successfully for the smelting of electrosteel. At the Taiyuan Steel Plant the metal is being tapped with 3 troughs.

There have been considerable improvements in rolling equipment and many of the rolling mills have been automated.

As well as improvements in the technical and economic factors there has been a steady increase in the range of production in Chinese steelmaking. No high grade steel was produced in old China. The rolled material was mainly commercial round and square sectioned steel of small and average dimensions. In 1952 in the Chinese People's Republic, more than 180 grades of steel were smelted and in 1957 there were 380. The number of types of rolled production in 1957 reached 5½ thousand. Chinese steel workers now smelt stainless, heat-resistant and acid-resistant steels, high speed steels, ball-bearing steels, spring steel, electrical steel and other carbon and alloy steels. As regards rolled materials, China now produces a number of profiles which it did not previously produce: rails, large varieties, thin sheet, etc.; seamless pipes are now being produced.

In 1958 the Chinese began to produce bimetallic sheet steel, high-tensile construction steel, high grade steel rails.

Workers at the Research Institute for Iron and Steel of the Ministry of Steel Production have developed a new technique for smelting a new grade of steel – a low-alloy high-tensile steel which is superior to the best American nickel steel. Workers at Peking together with workers at Tsinsi have successfully developed the production of sheet steel directly from the molten steel.

At the present time 88% of the country's requirements in rolled material is provided by the whole industry compared with 61% in 1953. This has led to reductions in imports and increases in the exports of ferrous metallurgy production. Whereas in 1953 China imported 850 thousand tons and exported only 10 thousand tons of rolled material, in 1956 its imports were reduced to 530 thousand tons and its exports rose to 210 thousand tons. Since

1955, China has been sending rolled material to the countries of Asia and Africa.

Favorable changes in the development and disposition of Chinese ferrous metallurgy during the years of Communist power and especially during 1958 will make possible another striking leap forward in 1959.

At the Eighth Plenum of the Central Committee of the Chinese Communist Party, it was observed that in 1958, 11.08 million tons of steel was smelted of which 3.08 million tons was obtained by the conventional method, and 8 million tons was smelted with modern equipment and fully meet the requirements of industry.

The Plenum foresaw an increase in steel production in 1959 to 12 million tons, all of this steel being smelted in modern equipment. The smelting of steel in 1959 was actually increased by 50% compared with 1958. The amount of steel smelted by the conventional method will not be included in the State Plan.

The Soviet people sincerely rejoice in the tremendous advances made by the industrious Chinese people under the leadership of the Communist Party. It can be stated with confidence that in its production of ferrous metals the Chinese People's Republic will not only reach one of the largest capitalist powers - Great Britain,—but will overtake it in the very near future. Soviet metallurgists wish their Chinese comrades further successes in their work.

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THE FIGHT TO BUILD A SOCIALIST SOCIETY

Yu. B. Khitsenko

Central Committee of the Trade Union of the Metallurgical Industry Workers

On October 1, 1959, the great Chinese people, the peoples of the Socialist countries and all progressive people in the world celebrate the tenth anniversary of the establishment of the Chinese Peoples' Republic.

Ten years is a short period from the historical point of view. During this period, however, the Chinese people have done a colossal job. Only ten years ago, no machine more complicated than a bicycle was produced in China. Now the Chinese Peoples' Republic has its own jet aircraft, ships, thousands of various modern machines, generators and metallurgical and mining equipment.

These splendid successes were achieved thanks to the selfless efforts of the Chinese people and the wise leadership of the Chinese Communist Party. At the same time, the friendly collaboration of Communist China with the countries of the Socialist bloc, first of all with the Soviet Union, played an important part in this development.

The friendship between our two great peoples is sacred and indissoluble, first of all because of the fact that they have a common goal — the building of Communism. This goal was confirmed in the historic treaty of friendship, alliance and mutual aid signed in February, 1950, and it was again stressed in the joint declaration of the Chinese and Soviet Governments in October, 1958, and in the communique issued on the occasion of the meeting of N. S. Khrushchev with Mao Tse Tung in August, 1958.

At present, workers, peasants and intelligentsia - all sections of the Chinese nation - are carrying on a successful fight for a further development of industry, agriculture and general culture. In the iron and steel industry the Chinese people have achieved unprecedented results.

In 1958, the production of the complete equipment of blast-furnaces, converters and rolling mills was started for the first time in the history of China; a blast furnace of 1513 m^3 volume and 850 tons per annum output capacity was designed and erected. Two 40-ton copper smelting converters were put into operation and the first Chinese blooming mill of a capacity of 600,000 tons per annum of rolled product was designed and built.

In 1958, the Chinese people successfully accomplished the enormous task of increasing the output of steel. The annual steel output was 11.08 million tons compared with 5.35 million tons in 1957. Out of this quantity, 8 million tons of steel was produced in modern plants. In this way, the increase in steel production constituted 49.5%.

In November, 1958, the production of steel at main metallurgical establishments was 228% higher than in January of the same year. The ratio of the blast-furnace working volume to the daily output was 0.675 and the average output of steel per 1 m of open-hearth furnace bottom per 24 hrs was 8.6 t.

This tremendous victory was only possible owing to the nationwide mass movement to increase the production of ferrous metals. Carrying out the instructions of the Party and the Government with respect to the construction of large, medium and small industrial establishments under the local or central management and to the application of both the old and modern methods of steel and pig iron production, the whole nation joined in the fight to increase the output of steel.

The workers of the Shitsinshan Iron and Steel Works built a converter shop of the capacity of 100,000 tons of steel per annum in 14 days. The workers of the first Iron and Steel Works in Pengsi attained an average ratio of working volume of the blast furnace to daily output of 0.496 in 1958 which is 53% above that of 1957. In October,

1958, the ratio of working volume of the furnace to daily output at that Works improved to 0.445. Since then it has always been at least equal to 0.476 and in March, 1959, it was 0.443.

At the Pengsi Works it has been decided that, at present, a ratio of the working volume to the daily output equal to 0.435 should be attained. This excellent initiative has been actively followed by all Chinese metallurgists.

Fulfilling the plan for the output of pig iron and steel, the personnel of the Anshan Metallurgical Combine at the same time assists in the development of the metallurgical industry in other provinces of China. Thus, in 1958, 10,000 skilled workers, economists and technical personnel were sent to other iron and steel plants. In 1958, the Scientific and Research Laboratory for Steelmaking at the Anshan Combine developed a new method of controlling the carbon content in steel during the steelmaking process, and, as a result, the duration of the heats was reduced by 30 minutes. The technical personnel of the No. 1 Blooming Mill substantially extended the field of application of pig iron with spheroidal graphite.

In recent years in China the production of steel in small furnaces by simple methods has increased substantially. At first many districts and people's communes set up small metallurgical plants. Then, this development entered a new stage – the setting up of small industrial establishments with modern equipment. In addition, in many Chinese provinces there are medium-sized iron and steel works provided with the most modern equipment. At the same time, several large modern iron and steel works are under construction.

The whole country is now assisting in the construction of the Paotow Metallurgical Combine, which is to play an important part in the development of the metallurgical industry in China. Paotow is one of the towns in Inner Mongolia. For over 200 years it was a market for furs and wool. It had a population of only about 70,000. Now Paotow is an industrial town with a population of 650,000. On the former bare steppe there are huge buildings of more than 200 factories and plants which supply the Paotow Metallurgical Combine. A blast furnace and an open-hearth furnace called the " Queen of Open-Hearth Furnaces," rolling mills and other shops will be put into operation this year.

The Shitsinshan Iron and Steel Works in Peking is expanding very rapidly. A new large blast furnace and a coke-oven battery – built in only 17 months – have been put into operation, and the construction of a sinter plant is nearing completion. Most of the equipment for the Works has been manufactured in China. After the completion of the first phase of the building program in 1961, the Works will produce 1.9 million tons of pig iron and 1.3 million tons of steel per annum.

The expansion rate of the Chinese metallurgical industry increases continuously. In just the first five months of 1959, seven blast furnaces of a total annum capacity of 980,000 tons and three coke-oven batteries were put into operation. While the construction of a medium blast furnace normally takes 5-6 months and of a large furnace 7-8 months, the No. 1 blast furnace of 255 m^3 volume at the Tsinan Iron and Steel Works in the Shantun province was erected and put into operation in only 3 months.

The large iron and steel works in China continuously increase the output of metal.

The Anshan, T'aiyuan and Maanshan Metallurgical Combines as well as Dae and Dal'nin Steel Plants are operating very successfully.

The Pengsi Iron and Steel Works achieved the best results in the country with regard to the utilization of the working volume of the blast furnaces and exceeded the production quota for the first half of 1959. At the beginning of this year a popular movement for the technical improvement of the blast furnace process has been started among workers and administrative personnel. As a result of this movement the ratio of working volume of the furnace to daily output has improved every month; from 2.00 in January to 0.411, and during the period from June 11 to 15, it constituted 0.399 on the average. Without the introduction of additional equipment, the Works increased the output by 58% compared with the first half of the previous year.

Chinese metallurgists have achieved remarkable results in the field of electric steel production. The average daily output per each thousand kva in the country increased from 18.62 tons in 1957 to 22.66 tons in 1959. At the Dal'nin steel plant the average output per 1000 kva constituted 35.4 tons in the first quarter of 1959, and over 40 tons in April and May of that year.

For the realization of the "Great Leap" in the development of metallurgy the friendship between Soviet and Chinese metallurgists is of great significance. Here is one example of a practical manifestation of this friendship. In September 1958, Wang P'ei-Chou, a rolling mill operator, was in the Soviet Union. He visited the "Krasnyi Oktyabr" Metallurgical Works in Stalingrad. At one of the Shops, Wang P'ei-Chou observed the operation of a pusher controlled by one man. He said he would like such a machine installed at his Works. The personnel of the "Krasnyi Oktyabr" Works sent drawings of the pusher and other machines used in the steel rolling industry to China. As early as the beginning of February of this year, automatic plate shears operating on the scheme of the shears at the "Krasnyi Oktyabr," as well as an automatic pusher, were put into operation at the 2nd Shanghai Steelmaking Works where Wang P'ei-Chou is employed.

Soviet metallurgists as well as the whole Soviet nation wish the great Chinese people best new successes in their march on the road to Socialism.

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THE DEVELOPMENT OF FERROUS METALLURGY IN EASTERN GERMANY

The workers of Eastern Germany are marking the tenth anniversary of the formation of their Communist State by important advances in the development of the national economy, including ferrous metallurgy.

Before the war there was very little ferrous metallurgy in Eastern Germany. A large part of the ferrous metals was imported from the Rhine-Westphalian region of Germany. Iron was only smelted at the "Maximillian-shütte" (abbreviated to "Maxhütte") in Unterwellenborn (Thüringen), the only integrated steel plant in Eastern Germany.

At the present time ferrous metallurgy is one of the most vigorously developing branches of heavy industry in Eastern Germany. It is developing successfully despite the fact that Eastern Germany is poor in metallurgical reserves: over the territory of the country there are small reserves of low quality iron ores containing 18-35% iron and there is no coking coal at all.

Almost all the iron ore is mined from the deposits of Harbke and Felbke (near Magdeburg) and also Schmiedefeld (near Gera). In the first five-year period (1951-1955) the mining of iron ore increased more than 4 times. The shortage of good quality ores is made up by imports, mainly from the USSR (from Krivoi Rog).

As regards the fuel for the blast furnaces, apart from the metallurgical coke mainly imported from Poland, extensive use is made in Eastern Germany of coke from brown coals, the geological reserves of which are estimated at about 50 billion tons.

Between 1949 and 1958 the volume of iron smelting in Eastern Germany rose by more than 7 times, steel by more than 5 times. In the first quarter of 1959 alone, as much iron was produced in Eastern Germany as for the whole of 1938 (see table).

The steady growth in production of ferrous metals in Eastern Germany is the result of the rapid restoration and redesigning of existing steel plants and also the inauguration of new large plants.

The first steel plants to be restored and redesigned were those in Unterwellenborn, Riesa, Thale, Gröditz and Henningsdorf (a suburb of Berlin).

At the Riesa Plant, as well as the restoration of the steel smelting shop with six 120-ton open-hearth furnaces, a new steel smelting shop was built with open-hearth and electrical smelting furnaces and a large section for shaped steel casting.

At the steel rolling plant in Gröditz a new rolling mill has been installed, foundry and forging shops have been built. In Delen a new plant has been built for high grade steels. To the west of Brandenburg in Kirchmezer the largest East German plant for conversion ferrous metallurgy has been built, including 150- ton open-hearth furnaces, blooming and several rolling mills.

The pride of Eastern Germany is the Stalin Steel Plant "Ost" in Stalinstadt and "West" in Kalbe. These plants produce most of the iron smelted in the country.

The Stalin "Ost" Plant is fully integrated. It was built at the start of the first 5-year plan. The blast furnace shop with the modern furnaces smelting conversion pig iron works mainly on imported iron ores and coke. The ore and coke are transported along the Oder-Spree Canal. At the "Ost" plant at the present time more than 1 million tons of iron is being smelted. When construction has been completed they will produce about 1.5 million tons of steel and rolled material; the number of production personnel will increase to 12 thousand.

The "West" Steel Plant which was built during the Communist administration works exclusively on East German low grade iron ores and brown coal coke. The iron ore comes to the factory from the Harbke and Felbke deposits which are situated to the west of Magdeburg. These deposits are a continuation of the large iron ore basin in Western Gèrmany. The brown coal coke comes from the coke ovens in Lauchhammer (Saxony-Anhalt).

The "West" Plant is on the banks of the Saal river. Two railway lines and the waterway provide excellent facilities for the rapid supply of raw material and for transporting the finished product. The low shaft furnaces of the "West" Plant are at a fairly high level of mechanization and automation and smelt cast iron.

The Production of Iron, Steel and Rolled Material in Eastern Germany (thousands of tons)

Material	Years										
	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959 (plan)
Iron . .	250	337	342	659	1078	1318	1517	1574	1663	1774	1816
Steel . .	606	999	1552	1886	2163	2330	2507	2740	2895	3048	3120
Rolled . .	357	781	1113	1331	1513	1711	1907	2036	2147	No	data

A USEFUL MANUAL

A. I. Sapko and Z. I. Sapko

In 1958 a brochure was published, written by A. P. Kul'batskii "High Speed Repairs of Electrical Steel Smelting Furnaces," (Metallurgizdat, Sverdlovsk, 1958).

The pamphlet gives general information on the design and operation of electrical steel smelting furnaces, on the basis of advanced experience in the organization and maintanance of furnaces at the Chelyabinsk Steel Plant. It also mentions the achievements of other steel plants, giving the planning, organization and practice of high speed maintenance; it deals with the maintenance of furnace linings and also with measures for increasing their life; it covers briefly safety problems during overhauls; it gives the requirements made of refractory materials which are used for lining and repairing electrical furnaces; reference data on refractory materials are systematized and given in separate tables.

The section entitled "Planning, Organization and Maintenance of Electrical Furnaces" deals with the preparation and carrying out of cold and general overhauls. As an example, a list of defects is drawn up and also complex charts for general overhauls.

The pamphlet tries to extend the experience gained on furnace overhaul to other plants.

As well as the good points mentioned there are some weak points in the pamphlet. There is little mention of experience in overhauling furnaces at other plants (furnaces which are charged from the top), there are no technical and economic data on high speed overhauls, and the introduction of new types of refractories. There is insufficient information on specific problems of safety techniques and the organization of labor when carrying out work in high temperature zones, etc.

Analyses should have been made of the desirability of using tamping blocks for lining the walls of furnaces, and also of the possibilities of mechanizing laborious processes when preparing the walls by pressing.

The pamphlet does not deal sufficiently with problems of the efficient shape for the furnace housing (tapered, stepped, cylindrical) and does not pay attention to unit repairs of mechanical and electrical equipment.

Based on the analysis of existing high speed methods for cold and general overhauls of electric arc furnaces, attempts should have been made to recommend a suitable method for overhauling large electric arc furnaces with a rotating roof. It is well known that the high speed method of general overhaul by tamping, which is described in the present pamphlet, is unsuitable for furnaces with a rotating roof, and the breaking of the walls with pincers during cold overhauls is also considerably complicated. In these cases it would therefore be desirable to use a high speed method with split furnace housings with a special removable crossbeam.

Despite the faults mentioned; the pamphlet is of considerable practical interest and can be useful for electrometallurgists and students of metallurgical universities.

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SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosénergoizdat	State Power Engr. Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LÉIIZhT	Leningrad Power Inst. of Railroad Engineering
LÉT	Leningrad Elec. Engr. School
LÉTI	Leningrad Electrotechnical Inst.
LÉTIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MÉP	Ministry of Electrotechnical Industry
MÉS	Ministry of Electrical Power Plants
MÉSÉP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTi	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NII ZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOÉ	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIÉL	Central Scientific Research Elec. Engr. Lab.
TsNIÉL-MÉS	Central Scientific Research Elec. Engr. Lab.-Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIÉSKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZÉI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us – Publisher.